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Battle Cruiser Contracts

EVERYONE who has carefully investigated the policy of the Navy Department in embarking upon the unprecedented program of naval construction authorized by the last Congress realizes that rapidity of construction is a paramount issue in the fulfillment of its aims. No fault can be found with the various departments responsible for the design of the fifteen different types of vessels embodied in this program. Due to the unremitting efforts of the bureaus in charge of the work, plans and specifications for all of these vessels were practically completed as soon as the naval appropriation act was approved. The celerity which attended the preparation of the designs, however, is not apparent in the placing of contracts for several of the most important items in the program—that is, the battle cruisers and scout cruisers. In spite of the fact that private shipbuilders anticipated these requirements and with a commendable spirit of patriotism prepared to meet them at the sacrifice of more profitable business, they are now faced with the possibility of this work going to government yards, where neither the necessary equipment nor—what is more important—the men are available for carrying out the work. The fairness of recent offers made by private shipbuilders for meeting this national need cannot be denied, and if their co-operation in the naval policy of preparedness is valued, their proposals deserve a better reception than antagonism and suspicion.

Coastwise Shipping

NO one can regret more keenly than does MARINE ENGINEERING that the Congress of the United States saw fit to change a law which has been on the statute books for considerably over a century and open the way for foreign-built vessels to enter our coastwise trade. Let us hope the new Federal Shipping Board will realize this mistake and make it one of its first duties to request Congress to right this wrong.

Meantime, coastwise shipping companies ought to protect themselves to the fullest extent against this possible invasion. This probably cannot be done by building larger vessels, nor is it probable that a much better type of vessel can be designed than that now in general use, but when it comes to terminals there is room for much improvement. In other words, it is not in carrying the freight that economies or improvements can be made, but in the terminals of the steamship lines where the cargoes are loaded and unloaded.

Exhaustive investigations were made recently by the Interstate Commerce Commission into the subject of water-borne freight, and careful analysis of these figures shows that the cost of the carriage of freight is only 40 percent of the total, whereas the cost of handling the freight at terminals is 60 percent of the total. It is terminal costs, therefore, that our coastwise lines must turn to, to make the necessary savings.

In the December number of this magazine it was stated that there is a potential saving of between $50,000,000 (£10,250,000) and $100,000,000 (£20,500,000) by introducing efficient apparatus at marine terminals for handling freight. Just think of the material reduction in the high cost of living, if steamship and steamboat companies could effect half of this saving and divide it fifty-fifty between stockholders and freight shippers! Purely as a business proposition, it is appalling that terminal costs should be half as much again as costs of carrying the freight.

In connection with this subject of terminal costs comes another opportunity for saving as well as for increasing the efficiency of water carriage, by steamship and steamboat companies employing their own motor trucks for receiving, as well as delivering, freight. Several steamship companies are already using their own motor trucks for collecting freight as well as for delivering it, and have thereby greatly increased their traffic. There must be profit in running trucks to marine terminals or no one would be in the business. This profit is just as important to the steamship or steamboat company as it is to the shipper, or whoever owns the trucks. What every traffic manager is looking for is increased profit, and it seems to us certain that in the near future steamship and steamboat companies will find it almost neecssary to use improved freight handling machinery and also to operate their own trucks, so as to expedite the handling of freight and to make it worth while for shippers to use vessels in preference to railroads whenever possible.

Increasing Use of Watertube Boilers in Merchant Vessels

EITHER shipbuilders are finding it difficult to secure early delivery of boiler plate from the steel makers, or else shipowners are beginning to recognize the advantages of watertube boilers, for recently numerous instances have come to our notice of the adoption of watertube boilers in merchant vessels. The latter reason we hope is true, for it has been proved again and again not only that higher efficiencies can be obtained with watertube boilers, resulting in material savings in the fuel bill of a steamship as compared with a similar ship equipped with Scotch boilers, but also that watertube boilers can be relied upon for safety and durability and that they can be operated at a lower cost of maintenance and are more flexible than ordinary Scotch boilers. These facts are convincingly set forth in the admirable paper by Mr. Charles F. Bailey, chief engineer of the Newport News Shipbuilding & Dry Dock Company, presented at the International Engineering Congress, 1915. Watertube boilers provide not only increased efficiency, but also a material saving in weight and space which in these days of abnormal freight rates and scarcity of tonnage means increased profits for the additional freight that can be carried.

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Refrigeration and Refrigerator Insulation on Board Ship

[COMMUNICATED]

Referring to the paper on "Refrigeration and Refrigerator Insulation on Board Ship," by Mr. Robert F. Massa, presented at the recent meeting of the Society of Naval Architects and Marine Engineers, an abstract of which was published on page 546 of your December, 1916, issue, there are several statements in the paper I would like to discuss.

USE OF SHEET CORK AS AN INSULATING MATERIAL ON BOARD SHIP

Where sheet cork is to be fitted to the ship's sides or between the overhead beams or around rivet heads of plating, the cost is prohibitive on account of the great amount of labor required to fit the cork so carefully as to avoid the air pockets which Mr. Massa very rightly states must absolutely be avoided. Furthermore, the insulation to be effective must be carried at least 1 inch or 2 inches clear of the face of the ship's beams or frames, and as this will usually require at least 8 inches of filling, I suggest a loose material which can be packed in between

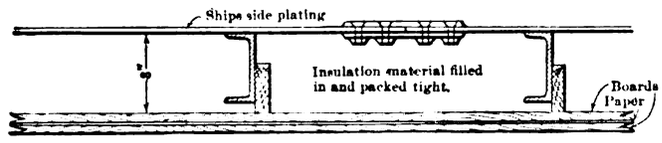

Fig. 1.—Sketch Showing How Insulated Material of a Loose Nature Can Readily Be Packed in Behind Boards to Form a Good Insulation.

the holding boards, as shown in Fig. 1. This is more satisfactory than sheet cork and also very much cheaper.

The relative cost of equal insulation between sheet cork and granulated cork when using 8 inches of the granulated as compared with 4 inches of sheet cork is in the proportion of 16 cents per square foot of insulated surface for the granulated cork and 54 cents per square foot of insulated surface for sheet cork. This does not take into consideration that in order to use the sheet cork between the beams or on the ship's sides it would be necessary either to fill in the whole 8-inch space with sheet cork, as in

Fig. 2.—Sketch Showing Difficulty of Fitting Sheet Cork Between Frames and Over River Heads, Etc., so That it Will Be Practically Air Tight.

Fig. 2, or else to fill in between the beams and frames with 4 inches of sheet cork and build a 4-inch sheet cork box around the projecting edge of each beam and frame, as in Fig. 3. If the former method of construction (Fig. 2) is adopted, the relative cost per square foot of surface would be $1.08 per square foot for sheet cork against 16 cents for granulated cork, and would result in a smooth, straight surface, as required for fitting the pipes and to prevent hot air pockets from forming between the projecting beams and frames. If the latter method (Fig. 3) be adopted, the cost of raw material would be nearer to 54 cents for sheet cork and 16 cents for granulated per square foot insulated surface, but the cost of labor in carefully fitting the sheet cork around all the projecting beams and frames would be very large and, from a construction point of view, I would consider it an almost impossible task to make it sufficiently air tight, as suggested in Mr. Massa's paper, and as required to give beneficial results.

Where partitions between rooms have to be erected, sheet cork is undoubtedly one of the finest insulating materials which can be used because it lends itself to such

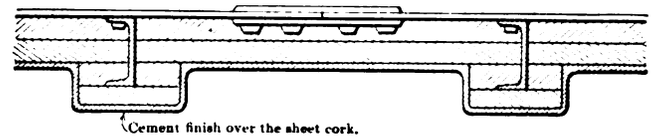

Fig. 3.—Sketch Showing Difficulty in Fitting Sheet Cork Around the Frames og a Steamer so As to Avoid Expense of Material Required to Fill Out Flush.

construction and gives the same insulating value for a less thickness, with, of course, a less waste in valuable space.

CARBONIC ACID MACHINES IN AN ENGINE ROOM

It is well known and has been thoroughly demonstrated by many hundreds of installations, both large and small, that carbonic acid machines are absolutely safe in so far as damage from escaping carbonic acid gas is concerned when placed in an engine room. The carbonic acid gas does not and cannot by escaping so contaminate the atmosphere in the engine room as to prevent the engine room staff from attending to their duties in operating the main engines, and therefore cannot jeopardize the safety of the vessel by driving the engineers from the engine room when the ship may be in a critical position.

Ammonia machines, it is well known, especially in large sizes, can become a menace to safety in this direction, but this is also well known to all people interested in marine refrigeration, whether as constructors or users, and therefore only the smallest sizes of refrigerating machines utilizing ammonia are ever placed in the engine rooms, and these are usually placed in a recess built into the top sides of the engine room so that any escape in ammonia gas from the machine would go upwards through the skylight or out through ventilators provided and cause little or no inconvenience to the operating staff.

Many of us who have had considerable experience with operating engineers, both at sea and on shore, know full well that it is not safe to form any hard and fast ideas on the merits of any particular type of machine from the engineering experience which any operating engineer may have had, as these men are particularly apt to run to extremes in their prejudices and condemn a type of machine in its entirety because one machine has given them trouble when possibly that particular machine may have been applied in an entirely wrong manner, and placed in a wrong position by some person ignorant of the correct method of handling or locating it. The small ammonia machines usually do not contain more than about 30 pounds of ammonia, and this amount is not sufficiently large to do any damage when the machines are placed as intended. This is borne out by the many hundreds of satisfactory ammonia installations so placed on shipboard.

PACKING WEAR

The mere fact that there are at least 7,500 enclosed type machines fitted with crank case packing, some of which have been in operation for over sixteen years, and none of which has had to renew the crank shaft due to wear in the packing space, is sufficient to offset Mr. Massa's remarks regarding the possibility of trouble in this direction.

Brooklyn, N. Y. LLEWELLYN WILLIAMS.

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River Steamboating

An "Old Salt's" Observations on Western River Navigation

BY "OLD SCOTCH"

ANYTHING you are not accustomed to looks strange, doesn't it?

A boy brought up in a great city who is suddenly moved to a small town on the prairies expresses surprise at everything he sees, and quite likely pokes fun at the "Rubes" and everything they do.

That is because of his lack of experience and general ignorance of things beyond his immediate horizon. But the older we get the less liable we are to be surprised at new things, and the more tolerant we become of other people's methods when they differ diametrically from those to which we are accustomed. Hence on the occasion of my recent visit to places on the Ohio River, with an idea of looking into the subject of river navigation generally, I was, owing to my mature years, in a receptive attitude, prepared to learn and not to scoff.

I know it is the general tendency of all salt water men —that is, those who are accustomed only to navigational methods on seas, bays and sounds—to belittle the steamboating methods on our great inland rivers. While admitting that river steamboats, with their twin stacks, huge stern paddle wheels and cumbersome cabins, which are the same now as in the days "befo' the wah," do look odd to those unaccustomed to them, my receptive attitude put me in an investigating turn of mind, rather than one of criticism.

Stern Wheel vs. Tunnel Stern Steamers

In common with most salt water people, my first question was as to why they do not at once discard the wheelbarrow type and take up the more modern propeller type, with tunnels if necessary. That is a perfectly natural question when we consider that even the side-wheelers have practically disappeared from ocean and sound navigation, to be supplanted by the now almost universal propeller type.

Rivers such as the Ohio and Mississippi, however, present entirely different problems. Here the water is always smooth, comparatively speaking; the current always runs one way, and varies from nil to eight or nine miles an hour; the depth, which at flood times may reach as much as fifty or sixty or more feet, is for the greater part of the time comparatively shoal—indeed, in many places as low as four or five feet. The Ohio River and its tributaries, the Monongahela and Allegheny, would not be navigable at all in the summer time were it not for the work of the Federal Government in canalizing these waterways with dams placed at proper intervals to keep the depth of water sufficiently high to permit of navigation. Splendid stone locks are fitted around these dams, the majority of them not less than 600 feet long. Hence, with the current always in one direction, the problem of transporting barges loaded with coal, iron ore, etc., resolves itself into one of pushing instead of towing.

In these narrow waterways it can readily be seen that much better control is had of a fleet of barges with the towboat behind instead of in front. With six or eight large barges laden with several thousand tons of cargo, celerity of control is a very important factor in undertaking the passage of locks. This is much more readily obtained with these large stern wheels than with quickly revolving, but necessarily small, propellers. Better and more prompt steerage way is given by the two or three large balanced rudders placed immediately ahead of the paddle wheel than the arrangement of rudders aft of the propellers, as customarily fitted. True, we saw a small towboat under construction having twin screws and tunnel stern, fitted with five rudders, one in each tunnel ahead of the screws, and three aft of the propellers. That, however, is but one of the many experiments which have been conducted to supplant the now almost universal stern wheel type of propulsion. Taking into consideration the shoal water, the necessity for prompt control in negotiating the locks, and other local conditions, we must admit that it will be many days before the old-fashioned stern wheel type will be entirely supplanted.

Propelling Machinery

Granting, therefore, that for the present at least the type of propulsion can very easily be defended, we will next look at the power plant. Up to five or ten years ago coal was almost a negligible factor, in the upper waters of the Ohio at least, for that commodity could be purchased very cheaply, often as low as $2 per ton. Here I have unwittingly fallen out of the river vernacular. Nobody on the rivers ever speaks of *tons* of coal; the bushel is the prevailing unit of measurement, 80 pounds to the bushel and 25 bushels to the ton of 2,000 pounds. Always, in speaking of the relative economy of different boats, they say, "She only burns so many bushels a day." Economy of power plant with such low cost of fuel was evidently a negligible factor. Now, however, with coal from $4 to $6 a ton (excuse me! I mean 5 to 7½ cents a bushel) the operators are taking notice of economy, as the fuel bills are mounting skyward along with the cost of living.

The prevailing type of machinery consists of two horizontal engines, each with about 5 to 7 feet stroke, fitted with poppet valves, and working on a crank at each end of the paddle wheel. The connecting rods are of wood, and, as can well be imagined, are enormous in size from a salt water viewpoint. Here, too, I am getting away from the language, as these rods in river parlance are always known as Pittman's, probably from the name of some early inventor. Up to very recent times these engines were nearly all built for high pressure, the exhaust being led up the stacks, thus furnishing a very good system of forced draft, if economy of fuel is not considered. In extremely cold weather the exhausts are directed into the paddle wheels on either side to prevent the paddle buckets from becoming heavily coated with ice. Before being led to the stacks, or paddle wheel, however, each exhaust pipe is led through a large drum, mounted on top of the "doctor," thereby constituting a very efficient feed water heater.

High-Pressure Boilers

The surprising thing to me was the steam pressure carried on these boats. Nearly all that I saw carried from 200 to 250 pounds pressure on the boilers. As they cut off at about two-thirds stroke, the exhaust goes up the stack with a considerable cough, and the approach of a

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river boat is easily heralded by the escaping steam, even in these days.

The steam plant usually consists of a battery of two, three, or even four of the old-fashioned "saw mill" type of boilers, externally fired with return flues, or in some cases tubes. While this type of boiler was discarded many years ago for ships in salt water, they have some advantages, principally of low height and center of gravity and their ability to handle muddy river water, which seem to commend them for this particular class of steamboats. I am not altogether prepared to state that the ordinary type of Scotch boiler, or a good marine water-tube boiler would be superior for this use, but my first impression is that they would be.

Some of the fittings they use on their boilers are, to say the least, likely to startle the average salt water marine engineer. For example, on the several vessels I visited I did not see a single water gage glass. Each boiler is fitted with but two gage cocks, but the main reliance for water height seems to be placed on a float gage placed on top of each boiler shell. A graduated sector with a pointer operated by the float through a vertical stem gives the height of the water in inches above the highest heating surface. While this apparatus would be quite unreliable on a ship rolling in a seaway, it seems to do the trick all right on these river boats, always operating in smooth water.

Disposal of Ashes

In one operation, at least, the river engineers can put it all over their sea-going brethren, and that is in the disposition of ashes. Instead of hoisting them laboriously by hand, or shooting them overboard through an ash ejector, the river steamboat fireman has an ash hopper right in the front part of the ash pan. The boats only draw two or three feet of water, hence it is very easy to fit an ash discharge pipe through the bottom of the boat, with a hopper extending two feet or so above the waterline. They do not even bother with fitting a cover over the hopper. The coal is dumped in the gangways right around the boilers, so that, except for long trips, the fireman can dispense with the services of coal passers. The holds of these steamers are only 4 or 5 feet deep and do not seem to be used for anything in particular, although I was informed that on packet steamers, when there is a rush of freight, barrels and packages are occasionally carried in the hold.

But to return to the power plants. The more modern steamers are being fitted with compound engines, some tandem and others cross-compounded—that is, the high pressure cylinder on one side and the low pressure cylinder working the crank on the opposite side. Even then they, with few exceptions, operate high pressure, as the river engineers seem to be chary of condensing apparatus. While this arrangement is, of course, not the most economical that can be devised, it is a great improvement over the single cylinder high pressure engines so largely used heretofore.

Some progress has been made with the use of triple expansion engines driving screws in tunnels, but there seems to be a consensus of opinion among those who have given the subject much thought that the screw-driven tunnel boats will never be universally adopted so long as the river conditions are as at present. It can readily be conjectured what would happen to screw propellers operating in tunnels when the boats necessarily get in shallow water, at times from 4 to 6 feet deep, with the bottom of the river containing branches of trees and other refuse.

It would seem, therefore, that the future trend of improvement in the economy of river transportation would be directed toward the development of an economical power for the driving of paddle wheels or stern wheels. By means of such improved devices as the latest link belt drives and reduction gears of various designs, it would seem that geared turbines and even Diesel engines will at no far distant date be adopted successfully. The advancing prices of coal will compel some such steps as those indicated to be taken.

The "Doctor"

No discussion of river steamboating would be complete without at least passing reference to the sacred "Doctor," as the feed pump in almost universal river use is termed. These are generally of massive construction from a salt water standpoint and consist essentially of a vertical steam cylinder driving a beam mounted on a vertical framework, which, by means of a connecting rod and crank, turns a huge fly wheel. From each side of the beam two vertical plunger pumps are driven, two for cold water from the river or tanks, discharging into the feed water heater, and two on the other side of the beam for hot water, drawing water from the feed heater and discharging the same through check valves into the boilers. The whole apparatus probably weighs four or five times as much as an ordinary vertical feed pump would to accomplish the same work, not to mention taking up about ten times as much space.

While this pump seems very crude and cumbersome to a sea-going engineer, there is much to be said in its favor. First, it is absolutely reliable, a very desirable feature for a feed pump, and, second, you are bound to get the full stroke of your pump, something which cannot be said of the ordinary type of feed pump. I do not suppose that any good river engineer would think of using any other kind of pump, as their "Doctor" certainly prevents all of the ills incident to boiler feeding. They are not pinched for weight and space, as on sea-going ships, so maybe their pet hobby is not so far wrong after all.

The Absence of Lagging

As I stated at first, it was my intention to learn rather than criticise, but there is one delinquency on the part of river designers which I cannot help criticising, and that is the almost total lack of lagging on the engine cylinders; in some instances, even, large lengths of live steam pipes were observed to be unlagged. To my economical soul this seemed almost like sacrilege. Heat units by the hundreds could be observed escaping and running around the engine room untrammeled. Luckily it was December weather, and their escape was accompanied by no physical discomforts on the part of the observer.

There is a certain air of romance about Western river steamboating, due no doubt to the writings of such eminent literary geniuses as Mark Twain, Hay and Dickens. In viewing the cabins and general fittings of these boats, one can well imagine that there has been but little change in these particulars since the days when these writers made the Mississippi River steamboats famous the world over. The huge gangplanks suspended by a derrick over the bow of the boat are the same, doubtless, as when Clemens sung out, "by the mark twain" from his lonely position as leadsman. The pilots still sound the sonorous whistle for river landings by pressing down on a lever with the foot. The same fancy work around the tops of the stacks exists to-day, as does the most fantastic scroll work in the ceilings of the cabins.

It is not generally known, but nevertheless the fact, that

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our present term of "stateroom" originated from the practice of designating the sleeping rooms on these boats by the names of States, such as Maine, New Hampshire, Louisiana, etc., instead of by numbers, as at present. Then, too, I was told a very interesting thing in regard to the living quarters of the officers and crew. These are almost invariably on top of the saloon deck, put there purposely so that the men may sleep in a place as far removed from the noise as is possible. This house is known as the "Texas," following out the general plan of naming after States, the idea being that Texas was the largest State, and so on board ship the Texas is large enough to accommodate the entire crew.

A novelty which attracted our attention was a number of fancifully painted boards hung alongside the lower deckhouses of all river steamers. These boards, each about 3½ or 4 feet long, 18 inches wide and 2 inches thick and containing two small slits, large enough to insert one's hands, aroused our curiosity. When informed that they were used for quick action lifebuoys, the mystery was explained. Although they do look odd, I believe I would rather have one to hold me up in the water than some ring buoys I have seen on ocean-going vessels which have about fourteen coats of white lead paint on them.

Although the majority of the river steamers have wooden hulls, the more modern of them are being constructed of steel, and the latter material is now preferred.

Being accustomed to having vessels in salt water docked at least once, and preferably twice, in a year, we were greatly surprised to learn that, with wooden hulls in particular, they are only docked once in four or five years. There appears to be no marine growth which attaches itself to the underwater body sufficiently to necessitate more frequent dockings. As the hulls proper are relatively a small part of the structures, we were informed that it is not at all infrequent that the upper works of some steamers outlast two or three different hulls. The slow-moving engines last an indefinite time, as the wear on them is comparatively negligible. Boilers, of course, have to be renewed about as frequently as they do on salt water craft.

Much is heard as to the decadence in river transportation nowadays. While it is true that the traffic is not now so great as it was some years ago before the paralleling railroads were built, there are strong indications of a considerable revival of river commerce. Especially was this noticeable on the Monongahela River, where we were informed that the traffic has doubled in a comparatively brief space of years. Many new towboats and barges are now being constructed along the banks of that river to meet the pressing demands of coal transportation for the great steel mills and other manufacturing enterprises. Much to our surprise, we were advised of the total cessation of coal shipments from Pittsburg to New Orleans and other points on the lower Mississippi. This condition is probably due to the great local demand for the coal mines in western Pennsylvania, and to the influx of the cheaper coal from the Alabama mines, which supplies all demands in that vicinity.

There is, of course, considerable local freight and passenger business between various points on the Ohio and Mississippi. From a strictly outside point of view it would seem that there are excellent prospects of a good increase in river traffic in the near future. Water transportation must be cheaper than by rail. The introduction of modernized power plants should result in great saving in fuel cost and consequent further cheapening of water transportation. Such passenger vessels as we saw had accommodations of the very crudest type. An improvement in this respect to anything like the comfortable quarters on lake and seaboard steamers should, it would appear to an outsider, result in greatly increasing the passenger traffic between river ports. Many American travelers would be lured to take trips on river steamers on the Ohio and Mississippi, were they assured of the same comforts and conveniences that they get elsewhere.

Use of Southern Yellow Pine in Shipbuilding

Qualities Which Make Southern Yellow Pine Superior for Shipbuilding Material—Its Uses on Naval and Merchant Vessels

BY A. C. POWERS*

THE prime object of the shipbuilder is to secure material of strength as well as durability, and to comply with the conditions resulting from the calculations and specifications made by the architect or designer. For the attainment of these objects no wood has been found superior to Southern yellow pine. That this is the case is clearly indicated by the vast amount of this wood used by the best shipbuilding concerns during the past hundred years.

Southern yellow pine, comprising the families *Pinus palustris* (Longleaf pine), *Pinus herterophylla* (Cuban pine), *Pinus toeda* (Loblolly pine), and *Pinus echinate* (Shortleaf pine) is found in practically all of the Southern States. It is one of the most important and valuable woods of the world, that importance being attained from a unique combination of properties. In the first place, it possesses qualities of strength and elasticity not found in other woods. And these qualities, combined with its comparatively light weight and the ease with which it can be worked, make it a wood peculiarly adapted to ship construction.

While it is true that other woods, such as fir and spruce, have been and are still being used to a considerable extent in the shipbuilding industry, this, in the opinion of the writer, is largely due to lack of familiarity in certain quarters with the superior qualities of Southern yellow pine. Having had many years' experience in connection with working Southern yellow pine for various purposes on all classes of vessels, from the construction of an ordinary float to the laying of decks on the Government's battleships—for which latter purpose this wood is extensively used—the writer has come to the conclusion that this material is by far the most important and valuable wood used by the Government in barge and ship construction, especially for work requiring strength combined with lasting qualities. Conclusive evidence of the value and dependence the Government places on Southern yellow pine is found in the vast number of coal and freight carrying barges it builds exclusively out of this

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material. Both experiment and experience have demonstrated that this wood possesses qualities especially adaptable to such use.

As compared with Douglas fir, perhaps one of the best-known woods in the marine field, Southern yellow pine has been found to be vastly superior for deck planking and similar purposes. This is due to Southern yellow pine's much closer and finer texture, which contributes to its excellent wearing qualities. A striking example may be cited in the case of the U. S. S. *Nebraska,* built by Moran Brothers at Seattle, and completed in 1907. In pursuance of the Government's policy to encourage the use of local products in construction work, Douglas fir was permitted to be used as an experiment in laying the decks of the vessel. The result of this experiment was so unsatisfactory that the Navy Department decided to continue the use of Southern yellow pine, in accordance with standard practice, and abandoned the use of Douglas fir. In fact, only in the case of some of the more recently built battleships has any substitute for Southern yellow pine been used. Teak is now being used experimentally on ships of the superdreadnought class, but the difficulty of obtaining this wood and its consequent enormous cost may be said practically to eliminate it as a factor in competition with Southern yellow pine.

In addition to the superior wearing qualities of Southern yellow pine as compared with Douglas fir and other similar woods, it is comparatively free from the tendency to shrink and check, which are peculiarly undesirable faults of the latter, and especially objectionable in wood used for deck planking.

The United States Engineer Corps constructs practically all of the barges used in maintenance and improvement work on the Mississippi River out of Southern yellow pine, as the wood possesses the lasting qualities which make it especially adapted to such use. The timber and planking used for such purposes, however, must be selected with a view to the particular fitness of the material for the work in hand, which in this case requires Dense Southern yellow pine, formerly known as Longleaf pine.

The strength of this wood can be increased materially by the process of seasoning. If used in a green state, the timber not only is lacking in strength, but is subject to continual change in bulk, form and stability, while the effect of moisture is to cause the tubular fibres to swell; hence if a plank is wet on one side, the fibres on that side will be distended and the plank will warp or bend. It should be noted, however, that the amount of shrinkage of this wood in length, when seasoning, is so inconsiderable that it may be disregarded by the shipbuilder.

Many manufacturers in the past were of the opinion that the bleeding of Southern Longleaf yellow pine was injurious to the timber, but a special investigation conducted by the United States Department of Agriculture, Division of Forestry, involving mechanical tests as well as physical and chemical analyses of the wood from bled and unbled trees, has completely disproved this theory. As a result of the Government's experiments it has been clearly demonstrated that bled timber is as strong as unbled, while the bleeding process was attended by little or no shrinkage of the wood or change in weight; the loss of resin affecting only the sap wood, proving that the durability of the heartwood was not lessened by the extraction of the resin.

Although this wood has attained a most enviable reputation and unrivaled popularity in the marine field, it may be pointed out that great care should be exercised by the builder in selecting the timber to be used, as timber cut at the wrong season—too young or too old—is not suitable for such work. If the material is manufactured from trees cut before they have reached maturity it is deficient in the properties of strength and durability and contains a greater proportion of sapwood. If allowed to grow too long, the heart of the tree becomes either brittle or soft, impairing its durability. As it is impossible to calculate in advance the strain that may be brought to bear on the different parts of wooden vessels, only material of dependable strength and durability should be used.

The construction of war vessels and large seagoing merchant vessels out of steel has reduced in late years to a large extent the use of Southern yellow pine, as well as other woods in ship construction. A century ago Southern yellow pine was the most important of all the woods used in shipbuilding, and to-day it remains the leading wood bought by shipbuilders, meeting the demand for a variety of uses. Some of the uses to which this wood is put in ship construction are as follows:

In steel battleships Southern yellow pine is used for decks, gun foundations, plank sheer, coamings and bending strakes, etc.

In steel merchant vessels it is used for decking, rails, bulkheads, foundations, sheathing, coamings, boat chocks, interior finish, hatch covers, etc.

In wooden merchant vessels it constitutes almost the entire construction, being used for hull, frame timbers, counter timbers, cant frames, carlins, deck stringers, deck frames, spirketings, beams, clamps, anchor chocks, anchor strakes, half frames, bulkheads, covering boards, base boards, main decks, berth decks, quarter decks, rails, transoms, sheathing, ceiling, masts, mast partners, waterways, interior finish, coamings, spars, chocks, breast hooks, floor timbers, ledges, etc.

In wooden barges Southern yellow pine is used for keelsons, frames, deck beams, decking, clamps, cross braces, flash boards, rake ends, fore and aft deck stringers, bulkheads, sheathing, anchor stocks, rails and hatch covers.

Edge-grain Southern yellow pine, designated as "rift-sawn" or quarter-sawn, has been used extensively by the Navy Department for decking on all classes of vessels, from the tug to the modern battleship, as this material is especially desirable for decking. The specifications admit no piece in which the angle of the grain exceeds 45 degrees, thus excluding all pieces that will sliver or shell from wear. It is particularly desirable to have material of this character for the decks of battleships, which are subject to unusual wear, owing to the large crew required to man these ships. Only wood that is hard, strong, tough, compact and durable can be used for such work.

Due to the excellent qualities of Southern yellow pine for ship construction, the demand for this wood has grown continuously, until at the present time it stands in a class by itself for such purposes; and, while the demand is already enormous, it must of necessity be much greater in the future on account of the increasing scarcity of white oak, which is the only wood used in ship construction in place of Southern yellow pine with the exception of teak, which, as before stated, is obtainable only at prohibitive prices. Shipbuilders, however, will find it much easier to secure suitable material for ship construction in the future than in the past, as the rules issued by the Southern Pine Association defining Dense Southern yellow pine eliminate coarse-grained material, which is unsatisfactory for ship construction, and admit only material that shows an average of at least six annual growth rings per inch and at least one-third summerwood, all as measured over the third, fourth and fifth inches of a radial line from the pith.

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Fig. 1.—The *Prometheus* Ready to Leave Dry Dock at Mare Island Navy Yard

Fig. 2.—*Prometheus* Undergoing Tilting Test in Dock

Towing the United States Collier Maumee from Mare Island to New York

Naval Collier of 14,500 Tons Displacement Towed Without Mishap a Distance of 5,260 Nautical Miles in 26 Days' Steaming Time

BY FRANK A. STANLEY

WHEN the U. S. S. *Prometheus* dropped anchor at Tompkinsville, Staten Island, New York, on April 2 last, she had completed a towing undertaking the biggest on record with the exception of the towing of the dry dock *Dewey* to Cavite, P. I., some years ago. This towing project involved the bringing of the U. S. oil tanker *Maumee* from Mare Island yard, California, around through the Panama Canal to New York, a journey of 5,260 nautical miles, the actual steaming time being twenty-six days, and the total time, including a stop of nine days at the isthmus, thirty-five days.

The *Maumee* has a displacement of 14,500 tons; a cargo capacity of 7,554 tons of oil; a bunker capacity for oil fuel of 1,658 tons. She was built at Mare Island yard and simultaneously with the construction of her hull at this yard her engines of the Diesel oil type were under construction at the New York navy yard. As she was to be assigned to service with the Atlantic fleet, the Navy Department decided that instead of having her engines shipped across the continent and installed at Mare Island, it would be preferable to have the vessel towed around to New York and have her engines installed at that place.

The naval vessel *Prometheus*, under the command of Captain F. D. Karns, was selected for the towing project, and the two ships got under way on February 27, 1916, passing out through the Golden Gate on the evening of that date and arriving at the Government anchorage at Tompkinsville, exactly five weeks later.

Details of the Prometheus

The *Prometheus* is the latest of our navy's repair ships, and is really a floating shop with every mechanical department aboard which would customarily be found in a machine plant ashore. The ship has complete machine shops, iron and brass foundries, boiler and plate shop, forge shop, pipe and sheet metal shops, pattern and wood working shops, optical department, and so on, and carries an immense supply of all kinds of materials likely to be required in the handling of repairs for the different vessels in the fleet.

Her machine tool equipment alone represents an outlay of over $56,000 (£11,500), and this, with the machinery in the other mechanical departments, brings the total up to nearly $80,000 (£16,400). The tools in the machine shops range in all sizes up to capacities sufficient for the heaviest work likely to be required. The two gray iron cupolas in the foundry have capacities up to 2 tons per hour, and the forge shop has, among other equipment, a steam hydraulic forging press, of 150 tons capacity. In addition to the departments referred to there is a complete drafting office, and, further, a planning department for laying out and following through all repair work handled on board.

The normal displacement of the *Prometheus* is 12,585 tons; length over all, 465 feet 9 inches; breadth on load waterline, 60 feet 1 inch; mean draft, 26 feet. She has two vertical triple expansion engines with high pressure cylinder diameter of 28 inches; intermediate cylinder, 44½ inches; low pressure cylinder, 75 inches; length of stroke, 54 inches. The total indicated horsepower is 7,500. There are six Babcock & Wilcox watertube boilers with four doors to each furnace and with total grate surface of 493 square feet and total heating surface of 19,974 square feet. She has a bunker capacity of 1,576 tons. Her speed is rated at 16 knots.

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Figs. 1 and 2, showing the ship ready to be floated out of dry dock at Mare Island, give a very satisfactory idea of her proportions. At the time when these photographs were taken the vessel had just been given her tilting tests, and Fig. 2 shows the ship inclined to port under these tests. In this inclination test the big crane shown alongside the dock was utilized for swinging aboard some very heavy weights, which were placed on a car, which was adapted to travel on a narrow gage track placed crosswise of the vessel's deck. This carload of weights was hauled by block and tackle to the side of the ship, and the inclination then measured for future reference in trimming ship when coaling or handling cargo.

After the *Prometheus* had left the navy yard dock she steamed down to the government coaling station a few miles above San Francisco, where she received the coal

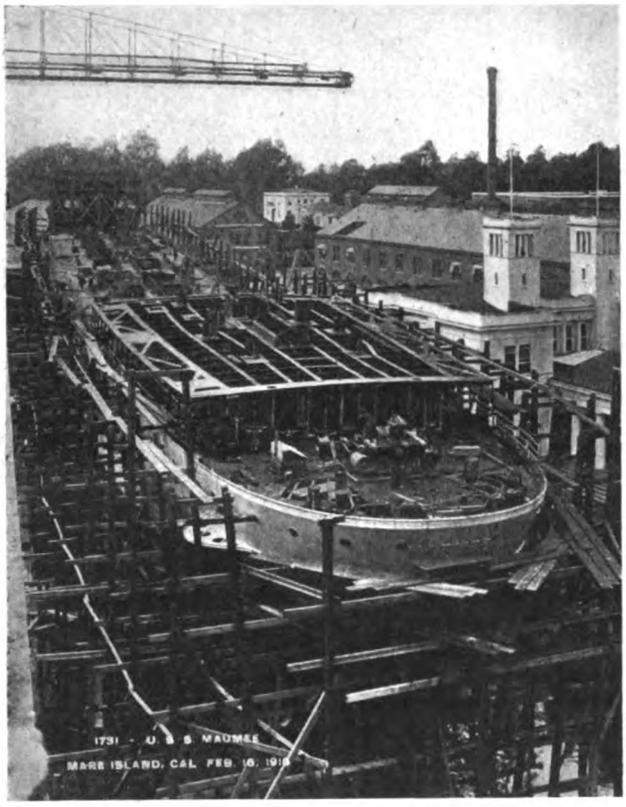

Fig. 3.—The *Maumee* in Her Building Slip at Mare Island Navy Yard

supply necessary for the voyage to Panama, the first stopping point on the schedule. At this coaling station a number of cars are operated along the top of the structure to bring in rapid succession one carload of fuel after another to the front of the station, where the coal is dumped down chutes into the ship.

The Tanker Maumee

Before taking up in detail a description of the towing operation, further brief reference to the tanker *Maumee* may be of interest. While the tonnage of this fuel supply ship has already been given, her actual size and proportions will best be gathered by inspection of Figs. 3 and 4. The first of these shows the *Maumee* approaching completion in her building slip at Mare Island, and this view conveys an accurate impression of the length and breadth of the vessel. Fig. 4, which is reproduced from a negative made while the *Maumee* was being passed through the Pedro Miguel locks at Panama, also shows the six electric locomotives which are used in the operation of taking big ships through the locks.

The *Maumee*, it may be stated, has a total length of 475 feet 7 inches, a breadth of 56 feet, a depth of hold of 33 feet 11 inches. Her mean draft loaded is 26 feet 2 inches.

For the towing of the *Maumee* the *Prometheus* had been equipped with a big towing machine and other special apparatus had been placed aboard to facilitate the carrying out of the undertaking. She was supplied with a new 7⅛-inch wire hawser (diameter 2¼ inches) of 300,000 pounds per square inch ultimate strength, and a very heavy towing arch was erected near the stern to carry the hawser clear of the ship's structure and to support it properly under all conditions of towing. This towing arch is clearly shown in Fig. 5.

From this view will be seen the very heavy proportions of the towing arch and the manner in which it was carried above the deck by stiff triangular supports, built up of steel plates and angles. This view also shows the location of the towing machine nearly fifty feet forward of the arch, the big driving gear and drum flanges being shown projecting above the top of one of the 5-inch guns on the quarter deck.

The Towing Machine

The towing machine, which was built by the American Engineering Company, of Philadelphia, Pa., is clearly illustrated on the deck of the vessel in Fig. 6. This view shows the heavy design and construction and illustrates the method of mounting the machine on the deck. The line drawings, Figs. 7 and 8, give in plan and side elevation the principal dimensions of the machine and show the method of operation.

Control of the Towing Machine

Referring to Fig. 7, the pilot valve which admits steam to the cylinders through the reverse valves is seen at *K*. This pilot valve is operated by a pin sliding in the slot in the valve stem *J*, the pin forming a part of the crank *H*, which is actuated by the segments mounted upon the same shaft as the hand lever *G*.

Steam can be admitted to the cylinders by hand by operating this lever, or this lever is operated automatically by means of the link *F*, which engages the cams 1, 2, 3 and 4. These cams are operated by a pinion *A*, which is fastened to the end of the drum shaft and meshes with the gear *B*, which is carried by the gear plate *C*.

When picking up a tow, the hawser is paid out by disconnecting the automatic gear and throwing the reverse valve lever *G* away from the drum.

After the required amount of hawser has been paid out, the machine is set for towing automatically by swinging the automatic out of gear by means of the hand lever, then the two large gears on the automatic gear plate *C* are revolved independently of each other until the cam *E*, which is controlled by the cam in the gear *D*, is completely exposed and on top. Then the reach rod *F* is dropped and the automatic gears are swung into contact with the pinion, care being taken that the cam just engages the slot in the reach rod and that the main valve is closed. The towing machine is then ready for towing automatically.

The three fixed cams 2, 3 and 4, on the disk of the automatic gear, are only used for closing the valves to a safe opening when the valve has been opened full, due to paying out more line than is required for ordinary towing. This closing to a safety opening stops the engine from racing when taking in the line under full head of steam.

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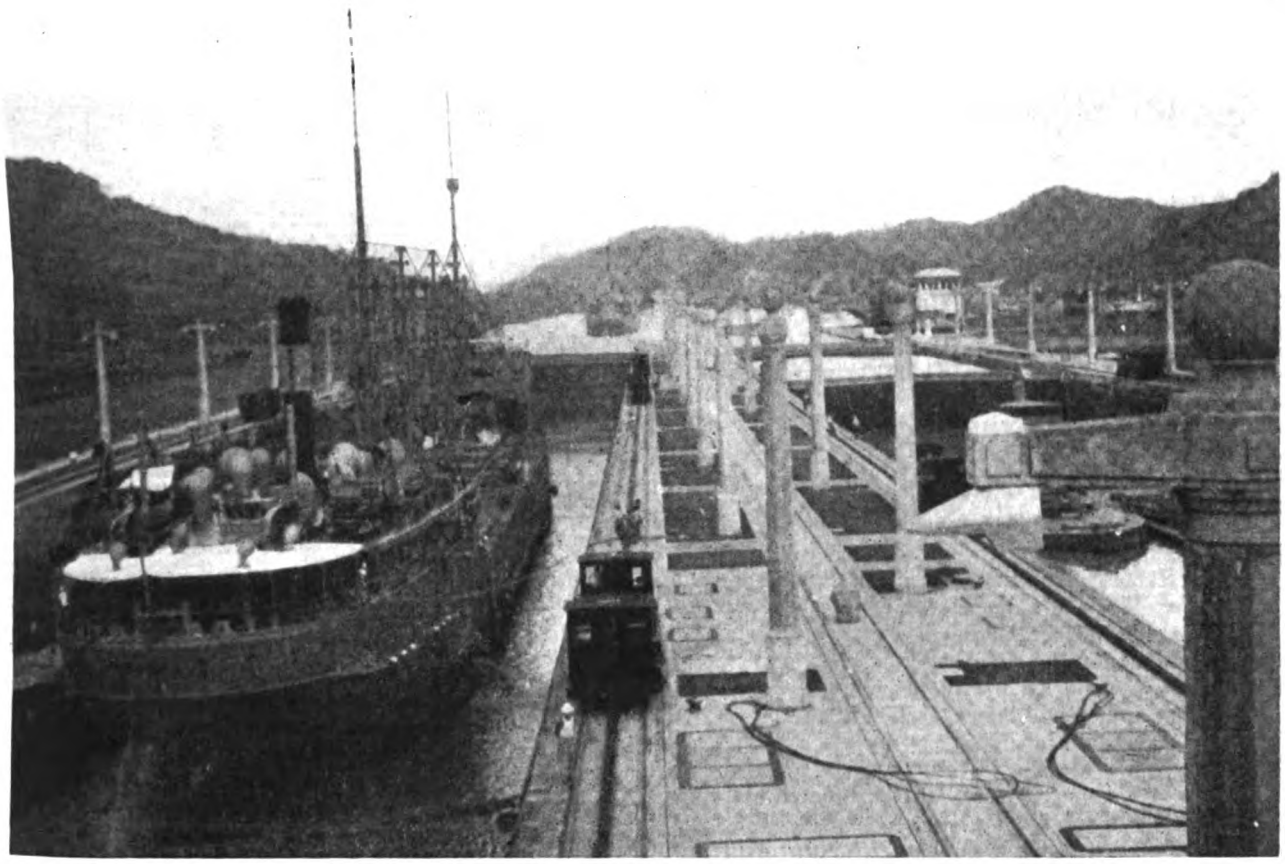

Fig. 4.—The *Maumee* in Pedro Miguel Locks, Panama Canal

The cams 2 and 3 are carried by the gear plate *C*, which is rigidly connected to the cam gear *D* and rotates on a pin. It is carried by a hand lever not shown. The cams 2 and 3 are rigidly fastened to the plate *C*, but the cam 1 slides in a radial slot. It is shown in its extreme outward position. It is guided by a cam slot in the cam gear *D*, which has 43 teeth on its outer periphery. The automatic gear *B* and the automatic cam gear *D* are driven by two pinions on an extension of the drum shaft. The pinions have the same number of teeth, but one of the gears has a few less teeth than the other gear.

The proportions of the two gears and the cam slot *D* are such that in one revolution of the cam gear *D* the cam 1 will move from its extreme outward position to its extreme inward position. The cam 1 will, when out to its full extent, operate in the slot of the reach rod to open

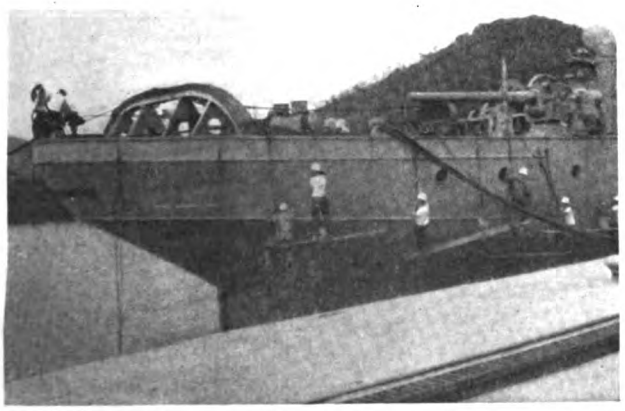

Fig. 5.—Towing Arch Over Stern of Ship. View Taken at Pedro Miguel Locks, Panama Canal

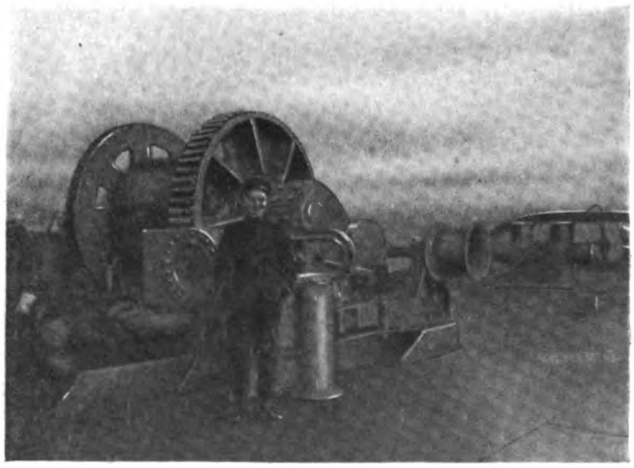

Fig. 6.—Towing Machine on After Deck of *Prometheus*

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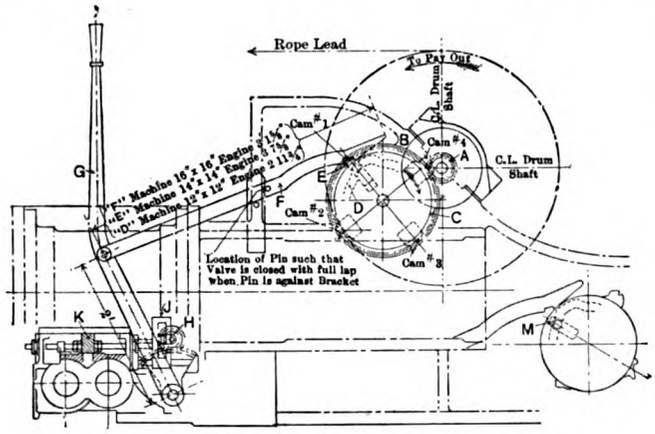

Fig. 7.—Side Elevation of Towing Machine

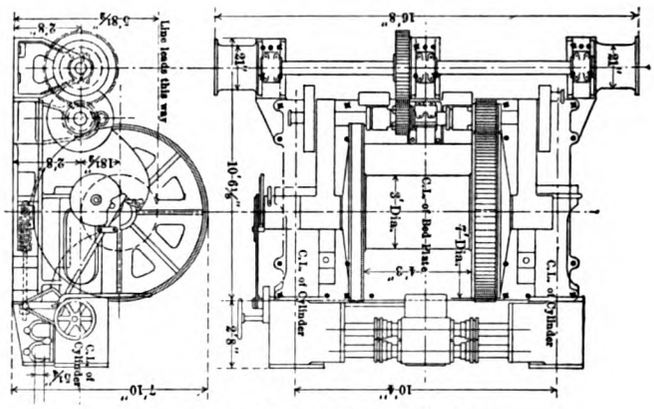

Fig. 8.—Plan of Towing Machine

or close the valve to its full movement. Cam 2 will operate in the slot in the reach rod to open the valve to its full extent, while cam 3 will close the valve down to a correct opening for safe speed when hauling in.

Change of Load

If, when towing, the load falls off, the engine will start to wind in and turn the gear plate *C* in the left-hand direction, and, closing the valve, will admit less steam to the engine until the load balances the engine power. If the load increases and the engine is overpowered, the gear plate *C* will turn in the right-hand direction and will open the valve to its fullest extent. If the line continues to pay out, the cam 1 will leave the slot in the reach rod *F* and be drawn to its inner position by the cam slot *D*, so that as it passes the slot in the reach rod *F* on the next revolution of the gear plate *C*, the cam 1 will not engage the slot in the reach rod *F*.

When the load falls off, so that the engine overpowers it and begins to wind the line in again, the cam 3 will almost immediately engage the slot in the reach rod *F* and close the valve down to the predetermined extent, at which it gives ample admission of steam to run the engine ahead at suitable speed, but not sufficient steam to let it run away under any circumstances.

The engine will then continue to wind in until it has made the same number of revolutions that it did in paying out, when the cam 1 will once more be thrust out by the cam slot *D* and engage with the slot in the reach rod *F* and bring the engine to rest at the same position that it was when overpowered by the load. If, however, it should happen that when the engine is winding in the line the load is again augmented and the engine overpowered, the cam 2 will engage the slot in the reach rod and at once reopen the valve to its fullest extent.

The valve *F* has ⅜ inch lap on each end. A motion of ⅝ inch from the center position to the right gives a port opening ¼ inch wide, which is correct for forward running, and the safety cam 3 is set to close the valve to this point.

When the admission port is thus at safety opening for free forward running, the exhaust port is wide open. A further motion of ⅜ inch to the right of the valve *F* gives a total steam opening ⅝ inch wide, which is not, however, for forward running of the engine, but to admit quickly the steam required to meet and oppose the retreating pistons when the engine is being overhauled by the load and the piston reverses its direction at the ends of the stroke. The cams 1 and 2 are set to move the valve to the right to this extreme position when engaged with the slot in the reach rod *F*.

It will be understood from the above that the valve is operated through intermittent gearing opening the port fully when the engine is overhauled before the drum shaft has made a single revolution, thus giving immediate increase in steam pressure up to full pressure in the admission pipe.

After the valve is opened, it cannot be closed until the same length of line that has been paid out has been recovered. The engine may be overhauled to pay out an indefinite length of line, but will bring it all back. The valve is closed by intermittent gearing, in stages, bringing the line back to the same length to which it was originally set.

All steam passages are of large size, enabling the steam to flow freely from end to end of the cylinders and to bank up quickly in front of the overhauled pistons after each reversal at the end of each stroke.

The valve opening, while the engine is being overhauled, is much larger than is necessary to drive ahead at proper speed, in order that full power may oppose the paying out at all times, but after the engine starts to wind

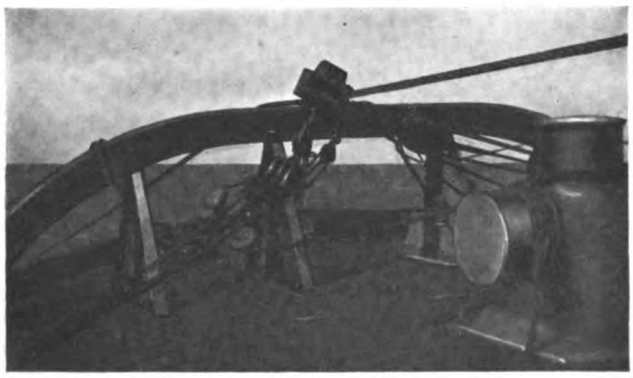

Fig. 9.—Original Method of Guiding Hawser over Towing Arch

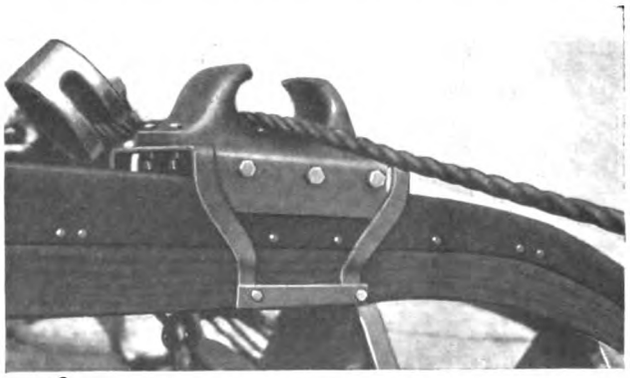

Fig. 10.—Sliding Guide Developed for Hawser over Towing Arch

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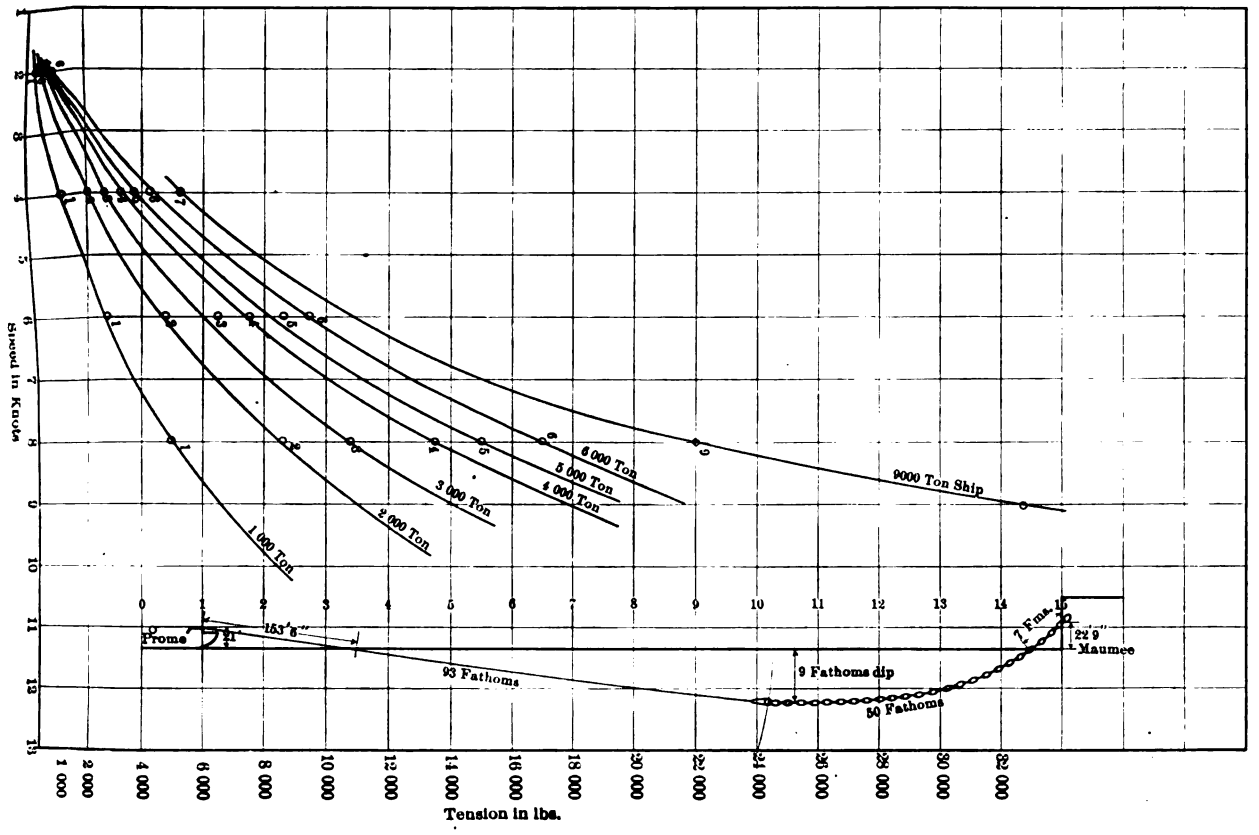

Fig. 11.—Chart of Towing Tension Curves and Method of Attaching Hawser to *Maumee's* Anchor Cable

in, the valve is partly closed to a point where the opening is sufficient to drive the engine at proper speed, but under safe control.

Arrangement of Hawser and Guide

It is obvious that for heavy towing work of the nature described precautions of all kinds must be taken to obviate the possibility of trouble in the control of the hawser and the vessel being towed, and it is essential that adequate means be provided for guiding the hawser properly in all conditions of wind and weather. At the beginning of the voyage the hawser was guided over the towing arch, as in Fig. 9, by a pair of very heavy tackle blocks, which were themselves secured by blocks and tackle at each side, as clearly seen in the illustration. Later on it was found desirable to modify this arrangement somewhat to give the hawser greater lateral freedom in relation to the arch, and a sliding guide was then developed and applied as in Fig. 10. This guide was kept in place on the towing arch by suitable side plates and by straps underneath, and was free to travel along the arch within the desired limits to accommodate itself to any slewing movement of the hawser due to swing and plunge of the vessel that was being towed.

Weighing the Tension on the Hawser

In order to make the towing proposition as flexible as possible and to provide an extra safeguard against undue stress on the hawser, Captain Karns adopted an interesting method of making the hawser connection back to the *Maumee* and of weighing the load on the hawser so that the speed of the *Prometheus* could be regulated to the requisite degree of safety. In the first place, instead of leading the hawser directly back to the *Maumee*, the anchor chain of the latter vessel was run out to a length of about 50 fathoms and the towing hawser was shackled to the end of this chain. The *Maumee's* anchor cable is made up of 2¾-inch stud links 18 inches long, the chain cable weighing 400 pounds per fathom. The great weight of the chain cable of, say, 50 fathoms, and the length of hawser connected to it, formed a deep catenary curve sagging 50 feet or more under the surface of the water, and the chain cable thus formed a spring or elastic connection capable of easing to a marked degree any sudden strains applied through the plunging or slewing of the vessels.

This arrangement is shown diagrammatically in Fig. 11, this chart showing also a number of curves which bring out the increase in tension on the tow line as the speed is increased. The chart covers ships of various tonnage and the curves are well worthy of study upon the part of engineers interested in nautical subjects.

The tension on the hawser was weighed at stated intervals each day and the speed of the *Prometheus* regulated accordingly. The method of finding this hawser load was as follows: A heavy platform scale was placed on the deck under the hawser at a point midway between the towing engine drum and the towing arch, and on this scale platform was placed an inverted jack with a strut reaching up into contact with the under side of the hawser. The jack was then operated to raise the hawser until a predetermined load was applied to the scales and the deflection of the hawser thus obtained was accurately measured by a gage consisting of a tall standard on which a horizontal arm was free to slide vertically, the amount of movement from normal position being read upon a scale attached to the upright standard. The readings were taken in sixteenths of an inch and a table was computed from which the actual tension on the cable at

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any time could be found in pounds directly opposite the deflection as measured in sixteenths of an inch.

USE OF THE TABLE

The distance between the center of the drum on the towing machine and the hawser bearing on the towing arch was 49 feet 7 inches. The scale was placed exactly halfway between the two points and was so adjusted that the scale beam came to balance when a net load of 420½ pounds was applied by the pressure due to lifting the center of the hawser from a straight line—that is, the tare due to weight of jack and strut was compensated for so that it could be disregarded, and only the load due to the downward thrust brought about by pressure against the hawser taken into consideration in computing the tension.

The formula by which the table was calculated is as follows:

$$\frac{W \times 49 \text{ feet } 7 \text{ inches}}{4 \times \text{deflection in feet}} = \text{tension in pounds.}$$

Here W represents the net weight on the scale and the length 49 feet 7 inches is the hawser measurement from towing drum to arch. The tension is in pounds and the deflection is in feet. In the table the quantities in the first column represent deflection in sixteenths of an inch. The second column giving the tension on the hawser in pounds:

Deflection in Sixteenths of an Inch	Tension on Hawser in Pounds
10	100,000
11	91,000
12	83,500
13	77,000
14	71,500
15	66,500
16	62,500
17	59,000
18	55,500
19	52,500
20	50,000
21	47,500
22	45,500
23	43,500
24	41,500
25	40,000
26	38,500
27	37,000
28	36,500
29	34,500
30	33,500
31	32,500
32	31,500
33	30,500
34	29,500
35	28,500
36	28,000
37	27,000
38	26,500
39	25,500
40	25,000

Based upon the weighed loads on the hawser, as referred to above, the speed of the *Prometheus* was regulated so that the tension was usually well below 50,000 pounds, although the ultimate strength of the hawser was 300,000 pounds. This means that under certain conditions of sea and weather the speed was dropped to as low as four knots, while at other times it was increased to eleven knots. The average rate for the voyage was nine knots.

The longest leg of the trip, from San Francisco to Balboa, a distance of over 3,000 miles, was covered without stop the *Prometheus* steaming steadily at over nine knots and making the run in just fifteen days.

The entire undertaking was accomplished with complete success from start to finish and reflects great credit upon Captain Karns, his officers and men.

MARINE SOCIETY HOLDS ANNUAL MEETING.—The one hundred and forty-seventh annual meeting of the Marine Society of City of New York was held on January 8. With one exception the former officers of the organization were unanimously re-elected for another year.

Protection and Lubrication of Propeller Tail Shafts

BY A. MC NAB, M. E.*

The propeller tail shaft on a ship is without doubt the cause of many anxious moments to the chief engineer at sea and to the superintendent engineer ashore. The tail shaft should receive the greatest consideration, owing to its inaccessibility for repairs at sea, and because of the fact that through it all effective power of the engine has to be conveyed to the propeller. If its construction is such that at this point undue friction takes place, it means a loss of valuable power.

For many years the tail shaft was lubricated with sea water, which was allowed to enter through grooves in the lignum vitæ bush. When the tail shaft had two liners this resulted in serious galvanic corrosion, which commenced at the ends of the liners and would gradually eat its way into the shaft until there was a positive nick to the extent of over half an inch deep, and records in many cases prove that the strength of the shaft was so impaired that the shaft became insufficient for its work; many a good and valuable ship has been lost through the result of this fracture.

The protection of the tail shaft has given food for thought to many engineers, and various means have been adopted to try and overcome this corrosive effect. Of late years, continuous liners have been used, extending from outside the stern stuffing box into the propeller hub. These long liners, though extremely costly, were a cure for the corrosion of the shaft, providing they remained perfectly tight and the joint at the propeller hub remained tight also, but if there was a flaw in the manufacture or any injury in fitting, loosening up due to vibration or strain of work through which water could enter underneath the liner, the result was in most cases worse than before, as the corrosion of the shaft was taking place unseen.

In order to avoid this galvanic corrosion, of late years the stern tube has in many cases been filled with oil. Where a suitable fitting can be obtained which will hold the oil in the stern tube, this means has substantially proved an effective cure, always provided that the oil used is non-corrosive and otherwise suitable for the purpose. Given a good fitting and a suitable oil there is no question but that the trouble from galvanic corrosion is a thing of the past for all time.

Another serious trouble connected with the usual open-ended stern tube is the entry of sand and grit into the stern bush. This sand accompanied with water makes an excellent mixture for grinding purposes, the result being that within a short time the shaft and bush become too slack for their work, with an attendant strain throughout the entire line of shafting and the usual "thump" heard in the engine room when the engines are reversed from "ahead" to "astern." A worn stern bush also produces excessive vibration throughout the ship.

Certain rivers are famous throughout the world for their injury to tail shafts and stern bushings, due to their sandy condition. Among the most notable are the Yangtze, in China; the Ganges, in India, and the Humber and Mersey, in England. Any arrangement which will keep the sand out of the stern tube of ships which frequent them is an immense boom to owners and engineers of steamers which are employed in these rivers.

Another serious trouble is the corrosive nature of the water on some coasts, caused by the decomposition of vegetable and other organic matter brought down by the

* President, the McNab Company, Bridgeport, Conn., sole representatives in the United States for Vickers' patent tail shaft appliances.

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inland rivers. We need not look far in our country to find sandy and corrosive waters which put the owners to serious trouble and expense in consequence of this.

Therefore, it stands to reason that if the stern tube can be kept full of oil, neither the water nor the sand can enter and cause corrosion and wear by their presence.

We do not have to appeal to the engineer when stating that water *is not* a lubricant. The ordinary layman's common sense is all the appeal needed. No engineer would think of lubricating his engines with sea water if he could get oil. But, even in this advanced age of engineering, we find many cargo and first-class passenger ships "lubricating" the most important bearing, the one which has to convey the whole effective power of the ship's machinery, with sea water!

Many notable foreign governments and progressive steamship owners have adopted some system of oil lubrication for their tail shafts, and the advantage of this system is such that there can be no doubt it will in due time become almost universal practice. Some years ago a prominent consulting engineer of one of the largest European steamship companies, who was using oil lubrication for the tail shafts of the many vessels under his supervision, expressed the opinion that within the next ten years lubrication for the tail shafts by oil instead of water would become a standard and universal fitting.

A unique example of the advantage of such oil lubrication is the ferry steamer *Storeton,* which runs between Liverpool and Rock Ferry. This boat is continually running in sandy water and her work is most severe, as her engines are reversed thirty-four times every 15 minutes, and she runs incessantly 7½ hours a day, the average mileage in three months being 10,000 knots. She was built by the Ailsa Shipbuilding Company, Scotland, who fitted her with Vickers' patent oil-retaining appliance. She commenced work about March, 1910, and her shafts were first drawn in 1913. They have recently been drawn for the second time, when it was found that after more than six years' continuous service in the sandy waters of the Mersey the wear of the bushes and shafts together has been practically nil and the liners on the shafts appear as though they had been burnished, while the quantity of lubricant consumed was very small—almost negligible.

It is only reasonable to suppose that with oil, being a much better lubricant than water, the friction in the stern tube bearings must be materially reduced where oil can be used, and when it is considered that the friction surface of the stern gland and stern bush forms an important part of the total friction surface of a marine engine, it follows that with oil lubrication a larger proportion of the effective power of the engine must be conveyed to the propeller. In turbine steamers which have been fitted with oil lubrication it is found that the vibration is very materially reduced, a matter of great importance in passenger boats and especially in hospital ships carrying wounded men.

Oil lubrication has similar advantages on twin screw brackets as on stern tubes. With oil lubrication of the tail shaft any kind of a bush may be used. Lignum vitæ, which is the old-time favorite of many superintending engineers, lasts longer when oil is used, but gun-metal, brass or white metal bushes are suitable, while cast iron bushes have been frequently used with excellent results. In addition to their cheapness, cast iron bushes have the advantage of being, in many cases, less liable to develop galvanic corrosion outside the after-end of the stern tube.

Why is an Air Port?

"Old Mac", the Veteran Ship Draftsman, Explains the Practical Details of Air Ports and Their Installation

ABOUT a week after the "Why is a Door?" conversation, Old Mac had again come into the office after lunch and was sitting looking out of the window at a couple of submarines that were playing around a mile or so off shore. His gaze went past their low, heavy gray lines to the black high streak of a tramp that was pretty nearly hull down.

Mac and the fat chief engineer of this boat had indulged in frequent friendly and almost affectionate conversations while she was being overhauled in the yard, and as he looked he remembered the chief, the conversations, and the locker in the chief's room. As he remembered, his face relaxed and he smiled in a satisfied way.

Young Stevens and "Tek" had their heads together and were talking in an undertone. When Mac smiled "Tek" gave Stevens a nudge. Young Stevens went over and brought Mac out of his day dream with:

"Mr. Mac, why is an air port?"

Old Mac looked up in a startled sort of a way and I believe if it had been anybody else but Stevens some very hard, fast talk would surely have been started.

"Tek" moved over next to Stevens. Mac looked them over slowly.

"Why is an air port? Huh!" he exclaimed. "Well, an air port was invented to let air in and out. Incidentally it lets in light and you can look through it. It is a ship window made of brass or composition. They are usually round because it is easiest to finish them in this shape. On passenger boats rectangular air ports are used in some of the more elaborate quarters. On these boats rectangular air ports are located under the berth in the side of the upper deck house so as to light and ventilate staterooms below through a short, bright trunk. The gear for operating the port is worked from below. The only square air ports I ever heard of were those that an Irish friend of your father's used to josh the riggers about. He always claimed that the Swedish ships have square air ports so that the sailors can stick their square heads through them.

"An 8-inch air port is a small one and 18 inches is a large one; 12 inches and 15 inches are common sizes. A man can squeeze through an 18-inch port and not through anything much less. It lets in more light and is a fine ventilator, but it costs more money and means a wider spacing of stiffeners or frames to clear. You fellows know, of course, that an air port hinges inward and is therefore on the inside. Near the waterline and where there are hard weather conditions air ports are smaller because they are stronger. Here also fixed lights are used. Deadlights and specially strong covers are some-

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times fitted where there is danger of the air port's failure.

"A 12-inch air port weighs complete with a cover about 100 pounds and costs installed about $25 (5/4/2).

"Air ports are pretty well standardized. Most firms have standard drawings and patterns for various sizes. Some builders buy them on the outside. Not long ago we got a lot of them from the Delaware Marine Supply Manufacturing Company. They had them on hand and we were rushed. The details of an air port need not bother you. Just see that you get clearance—that is all that is necessary. On outside plans remember to be guided by figures alone and be careful how you use some of those. What we have to worry about is their location and what you have seen a lot of times—an air port schedule.

"An air port has to be located in the shell or house plating, so that its frame does not foul plate laps, stiffeners, frame flanges, etc. It must be possible to open the light and hinged cover without fouling stiffeners or stiffener and beam brackets. The bolting is universal in the air port frame—that is, the number of holes is such and they are so arranged in reference to the vertical and horizontal axes that the cover, light and frame can be changed from up to down or sideways. Generally both cover and light hinge up and are held by a latch hook or by a hook and chain fastened by a small eyebolt. However, the cover may hinge up and the light to the left or right.

"Five feet three inches is the height of the average person's eyes, so that the center of the light in an air port should be about 5 feet 3 inches above the floor or deck. Remember that when a wood deck is fitted you must allow 2½ inches to 3 inches and locate the air ports on the steel plans just that much higher. Some fellows can only see steel when they work on steel plans. Of course air ports must be located to conform to the general appearance scheme of the outside of the deck house as regards panels, pilasters, doors, etc. The arrangement of furniture in the rooms has to be considered also.

"It used to be that the yard wanted the early location of air ports, etc., so that the hole in the plate could be cut to advantage. It is all right to give them this early location unless some change in the quarters or furniture details does not have to be made later. You can't move a cut hole, and nearly always somebody wants to rearrange quarters at the last moment, so it is wise to remember to forget to show the detailed location of air ports. Now, however, a fellow in the yard has no trouble in burning out an air port hole after the plating is in place and riveted up. Often an air port is the only way to ventilate some compartment or the only good way for electric and compressed air leads. Then an air port or two may be cut out early in the game to please the yard, but remember this early location is dangerous business.

"Sometimes an air port may leak a little and at times they all sweat so that a cupped drip is provided either as a part of the frame of the air port or built into the ceiling around the air port. A small drain is fitted to carry off this drip. Where the flare of the ship is excessive special attention must be paid to locating the drain at the lowest point.

"In way of anchors, etc., where the glass in the light might be broken the frame of the air port does not protrude through the shell plate, and the plate is not cut except with a few 2-inch diameter holes in the way of the light.

"An air port schedule is a tabulated list of the air ports on the ship. It shows the number wanted of each kind, size, etc. It gives also the length of the spigot or lip part of the frame that protrudes about an eighth of an inch beyond the outside of the plate. The thickness of the plate, of course, determines the length of the spigot. The air port flange and the spigot edge are generally flat, and where the shell plate is curved a tapered liner is supplied to fill up this curvature, the spigot being made correspondingly longer. When weight saving is important the frame flange is cored out and a narrow chipping strip is provided that can be cut to suit the curved plate. This is done on torpedo boat destroyers. Here the frame flange is also scalloped out between the holes to save weight.

"This schedule or list shows what kind of glass is wanted in the lights—clear, frosted, or wire inserted. When an air port opens into a private room, bath, etc., from a deck or public part of the ship, ground or frosted glass is used in the light or some sort of blind is fitted on the inside.

"The schedule shows, also, where a grating or screen is to be furnished. Fine bronze wire insect screens are often fitted to keep out mosquitos and flies. Heavier screens or grating are fitted to protect the light and partly close the opening in steerage quarters, storerooms, cells, etc., where trouble would result from too ready access or passage.

"Again this list must state whether or not the air port is to have a cover. It should also state how the port hinges and specify how the drain is to be furnished.

"Most weather air ports have a watershed and the list should take care of this also. This watershed is a brass or composition rim or lip that is fastened on the outside of the plate and extends over the upper half of the port so as to shed water clear of the port proper. It has about the same diameter as the spigot and fits down on it, being fastened to the plate with screws or tap rivets.

"For the purpose of ventilation when there is no regular system, a sheet metal scoop piece is fitted to the open air port in such a way that it extends out against the direction of the wind and forces air in through the port. It has a latch and can be set to suit.

"This schedule takes account of fixed lights, deck lights, prisms, etc. In the case of a wood deck this flange of the light frame is let into the wood and heavy glass (preferably wire inserted) is used. For steel decks this flange is on top of the deck and has a chamfered edge.

"Remember that in the pilot house the fittings around the compass are sometimes made of non-magnetic material. On the smaller boats fixed material within a radius of about eight feet should be non-magnetic. When conditions warrant it this radius should be increased to about twelve feet. Movable material within a radius of fifteen feet should be non-magnetic."

The whistle blew. Stevens and Tek hurried over to their boards. Mac took another long look at the submarines, put on his glasses and with a resigned expression started to alter a drawing that he had made about a week before and that some of the "higher ups" (as he calls them) had (to use their expression) changed slightly. The changes, though slight, were radical. The old man's pride had been hurt and he made no effort to hurry. He watched the submarines at intervals all afternoon.

ANNUAL MEETING OF ENGINE AND BOAT MANUFACTURERS.—The annual meeting of the National Association of Engine and Boat Manufacturers will be held at the United Engineering Societies Building, 29 West Thirty-ninth street, New York city, at noon on February 1.

SHIPBUILDERS ACTIVE IN NOVA SCOTIA.—Six shipyards in the vicinity of Parrsboro, Nova Scotia, are engaged in the construction of schooners. These vessels range from 200 to 600 tons each.

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Pushing and Speed Tests of River Towboats

Speed and Thrust of Tunnel Stern Towboat with Propellers of Varying Pitch and Area—Comparison with Sternwheel Boat

BY M. VON PAGENHARDT*

By permission of Major Smith, of the Mississippi River Commission, the writer, representing the Kansas City Missouri River Navigation Company, was given the opportunity of conducting a series of tests on the twin-screw tunnel towboat *Inspector* and sternwheel towboats *Wynoka* and *Saturn* for the determining of—(1) The thrust per indicated horsepower of the tunnel towboat *Inspector* with propellers with different pitch and area, while pushing against a barge tied to the shore, in a current speed of about four miles per hour; (2) The speed per indicated horsepower of the tunnel towboat *Inspector* with propellers of different pitch and diameter while running light. (3) The maximum thrust per indicated horsepower of the tunnel towboat *Inspector* and of the sternwheel towboats *Wynoka* and *Saturn* while pushing against a barge tied to the shore, in a current speed of about four miles per hour.

The purpose of this investigation was twofold: namely, the determination of the respective pushing power of the two different types of towboats under exactly similar conditions, and also the determination of the tendency of the curves thus obtained for the calculation of the maximum power obtainable in the tunnel boat screw of approximately five feet six inches diameter, or a sternwheel of approximately twenty-four feet diameter.

The tests were made October 7-17, 1915, under the supervision of Mr. Hilliard, superintendent of the United States dredge fleet of the Mississippi River Commission, by the writer, who was assisted by the junior engineer, Mr. E. S. Bonnell, and by Mr. D. J. Mackie, superintendent of the fleet of the Kansas City Missouri Navigation Company.

General Arrangements of the Test

In order to determine the thrust of a Western river towboat, which pushes its tow of barges instead of pulling it on a towline, arrangements had to be made to measure accurately this thrust of the towboat pushing against a tow securely anchored in reasonably deep water in a current equivalent to the upstream speed of a heavy tow. The current speed at this particular time was in the neighborhood of four miles per hour, or twice as much as during the low-water season, and therefore the speed of four miles per hour was equivalent to the upstream speed of a heavy tow.

The Government dredge fleet lying three barges abreast at the Arkansas shore afforded an excellent place for this pushing test. The depth of water outside of the fleet exceeded 40 feet, and a barge tied to the outside of this fleet was in comparatively unlimited water. Two dynamometers 17 feet center to center were fastened onto the stern end of a barge 80 feet in length and 24 feet in width, drawing only 12 inches, whereas the towboats were drawing at least 3 feet. Care was taken not to have any boat or barge alongside the towboat, so as not to interfere with the proper flow of the water to and from the propellers.

The dynamometers were in form of cast iron plungers with an area of 100 square inches each, allowing a reading of 100 to 1, and the gages were tested before and after the completion of the tests and corrections noted.

*Naval Architect, Kansas City, Mo.

For the determination of the generated power in the engines, indicators were installed, one on each cylinder, and the testing force was distributed in such a way as to read simultaneously the thrust on the dynamometers, the boiler pressure, the number of revolutions per minute and to take a double set of indicator-diagrams on each cylinder—during each period of constant revolutions.

For the speed test no special arrangements were made, as there is laid out and properly maintained a measured mile opposite the dredge plant, following an easy bend of the river in mid-channel.

The main particulars of the vessels to be tested were as follows:

Twin Screw Tunnel Towboat "Inspector"	
Length between perpendiculars	144 feet
Beam, molded	26 feet
Depth, molded	6 feet
Coefficient of waterlines equal	.1821
Coefficient of typical cross section	.989
Block coefficient	.705
Draft to C. W. L.	3 feet 6 inches
Draft under test conditions	3 feet 9 inches
Displacement under test conditions	300 tons
First set of screws (built-up propeller): Diameter, 5 feet 6 inches. Pitch, 8 feet. Developed area each, 12.5 square feet.	
Second set of screws (built-up propeller): Diameter, 5 feet 6 inches. Pitch, 7 feet 9 inches. Developed area each, 15 square feet.	
Third set of screws (solid propeller): Diameter, 5 feet 6 inches. Developed area each, 16.6 square feet. Pitch of starboard wheel, 6 feet. Pitch of port wheel, 5 feet 6 inches.	
Number of engines	2
Diameter, high-pressure cylinder	10 inches
Diameter, intermediate-pressure cylinder	15¼ inches
Diameter, low-pressure cylinder	25⅝ inches
Stroke	18 inches
Revolutions per minute	190
Indicated horsepower	750
Sternwheel Towboat "Wynoka"	
Length between perpendiculars	171 feet 6 inches
Beam, molded	36 feet
Depth, molded	5 feet 6 inches
Draft to C. W. L.	4 feet
Draft under test conditions	3 feet 6 inches
Displacement under test conditions	540 tons
Two high-pressure engines.	
Bore of starboard engine	22¼ inches
Bore of port engine	22 inches
Common stroke	96 inches
Indicated horsepower at 22 revolutions per minute	800
Diameter of wheel	24 feet
Length of bucket	23 feet
Width of bucket	30 inches
Number of buckets	16
Sternwheel Towboat "Saturn"	
Length between perpendiculars	99 feet
Length overall	118 feet
Beam, molded	20 feet
Draft under test conditions	3 feet
Displacement under test conditions	145 tons
Two high-pressure engines.	
Bore of engines	9½ inches
Common stroke	60 inches
Indicated horsepower turning 24 revolutions per minute	137
Diameter of wheel	15 feet
Length of bucket	13 feet
Width of bucket	20 inches
Number of buckets	13

Method of Conducting Tests

Readings were taken every fifteen seconds simultaneously at both dynamometers, revolution counter, steam gage, vacuum gage, and two sets of cards were taken on each engine, while the revolutions per minute were kept constant for a period varying between five and twelve minutes.

At least four points were determined of the curve for each propeller. The current of the river was measured

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whenever the weather permitted, and the resistance of the pushing boat in the current was determined by hanging the boat on one dynamometer, which resistance was introduced as the constant for all readings of that boat.

The tests were made in four groups, as follows:

1. Pushing test of *Inspector* with first set of propellers.
2. Speed test of *Inspector* with barge in tow, first set of propellers.
3. Speed test of *Inspector* running light, with first set of propellers.
4. Repeating speed test running light, with first set of propellers, after removing forward backing rudders, which were found badly bent, and after straighening after rudders.
5. Repeating pushing test of *Inspector* with first set of propellers.
6. Pushing test of *Inspector* with second set of propellers.
7. Speed test of *Inspector* with second set of propellers.
8. Pushing test of *Inspector* with third set of propellers.
9. Pushing test of *Inspector* with starboard propeller only of third set of propellers.
10. Speed test of *Inspector* with port propeller only of third set of propellers.
11. Speed test of *Inspector* with third set of propellers.
12. Pushing test of sternwheel towboat *Wynoka*.
13. Pushing test of sternwheel towboat *Saturn*.
14. Speed test of sternwheel towboat *Saturn*.

RESULTS

The maximum pushing power of the twin-screw towboat *Inspector* was 18,841 pounds with 979.1 indicated horsepower, or 19.25 pounds per indicated horsepower. The maximum pushing power or thrust of the sternwheel towboat *Wynoka* was 17,700 pounds with 587.1 indicated horsepower or 30.2 pounds per indicated horsepower, or the thrust per indicated horsepower of the sternwheel towboat was 57 percent higher than the thrust per indicated horsepower of the tunnel towboat *Inspector*. If, however, we compare their displacements we find that the pushing power of the tunnel towboat was 62.8 pounds per ton of displacement against 32.8 pounds per ton of displacement of the sternwheel boat *Wynoka*, or superior to the sternwheel towboat by 91 percent. The fact must be mentioned, however, that the *Wynoka* was only allowed 165 pounds steam pressure instead of 200 pounds, which she carried when a new boat. With the latter pressure she might have indicated 700 or 750 indicated horsepower under similar conditions, or as much as 40 pounds per ton of displacement, in which case the tunnel boat *Inspector* would still have an advantage of 57 percent in thrust per ton of displacement over the sternwheel boat *Wynoka*.

The additional displacement, however, of the *Wynoka* over the *Inspector*, 540 tons against 300 tons, showed an additional resistance in the four-mile current of only 21.4 percent, 825 against 680 pounds, leaving a net thrust of 18.6 pounds per indicated horsepower in the *Inspector*,

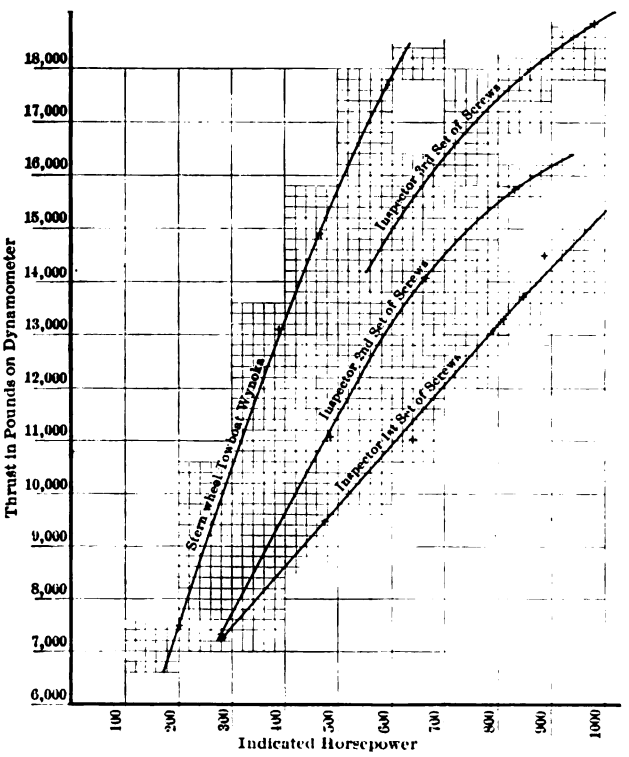

Fig. 1.—Pushing Test; Relation of Thrust and Indicated Horsepower; Twin-Screw Tunnel Towboat *Inspector* and Sternwheel Towboat *Wynoka*.

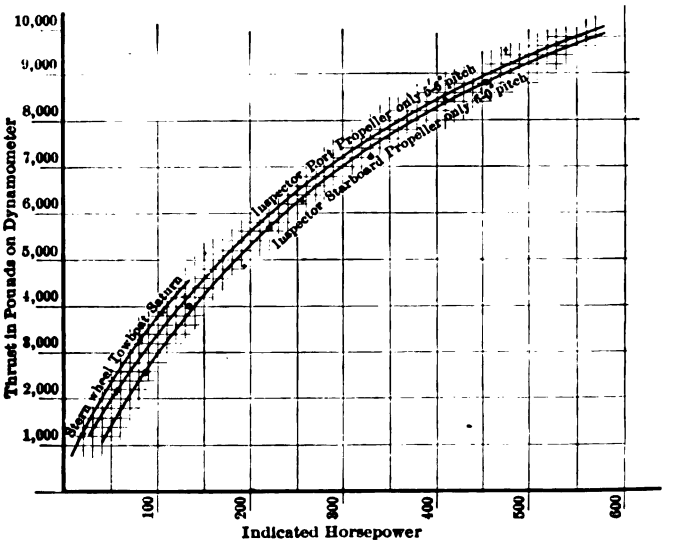

Fig. 2.—Pushing Test; Relation of Thrust and Indicated Horsepower. Twin-Screw Tunnel Towboat *Inspector* and Sternwheel Towboat *Saturn*.

against 28.8 pounds per indicated horsepower in the *Wynoka*, which is still an increase of 55 percent of net thrust per indicated horsepower at this current speed of four miles per hour. At the higher towing speeds this difference will still be less but as long as we have to do with towing speeds there will still remain a superior net thrust per indicated horsepower of 40 to 50 percent in the sternwheel towboat over the tunnel towboat of similar dimensions.

The thrust of the tunnel towboat might be increased considerably with a still further reduction of the pitch, a still further increase in revolutions per minute, and a still further increase of the developed area. So may the thrust of the sternwheel towboat be increased by reducing the diameter of the wheel, increasing the area and increasing the revolutions per minute. The attained comparative data will, therefore, still be indicative of the comparative thrust efficiencies.

We further find that the fuel consumption per hour of the 960 indicated horsepower tunnel towboat, figuring 2½ pounds per indicated horsepower, is 2,400 pounds, whereas the fuel consumption of the 630 indicated horsepower sternwheel boat having high-pressure engines, figuring five to six pounds of coal per indicated horsepower, is 3,150 pounds to almost 4,000 pounds per hour. Of course, this comparison of fuel consumption is no criterion for the sternwheel boat type in general, as the fuel economy in tandem compound engines could easily be reduced to three pounds per indicated horsepower, but the comparison is indicative of the importance of multi-stage expansion of steam and the general fuel saving and its effect in plant efficiency.

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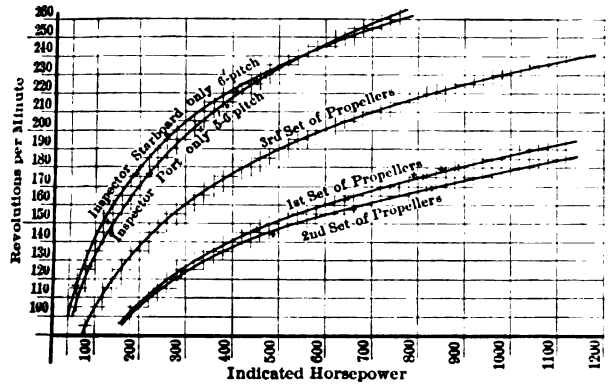

Fig. 3.—Pushing Test; Relation of Revolutions per Minute and Indicated Horsepower. Twin-Screw Tunnel Towboat *Inspector*.

The tests on the *Inspector* allow us to make the following deductions:

Deductions from Tests of Twin-Screw Tunnel Stern Towboat "Inspector"

The thrust per indicated horsepower increases with the increase of the developed blade area and with the decrease of the pitch.

An increase of the revolutions per minute results in a higher thrust per blade area up to about 260 to 300 revolutions per minute, at which point the thrust per blade area would begin to decrease.

A propeller turning 260 to 300 revolutions per minute is more efficient than a propeller designed to turn only 180 to 200 revolutions per minute.

A tip speed of 4,000 to 5,000 feet per minute is desirable.

A ratio of pitch to diameter of one, or even less than one, is desirable.

A ratio of developed area to disk area of 70 percent and more is desirable.

A propeller of solid construction is preferable to a propeller of the built-up construction, as the solid propeller offers less resistance to the water.

Whatever applies to a towing propeller applies also to a speed propeller, or a good towing propeller is also a good speed propeller, whereas a good speed propeller is not always a good towing propeller. A propeller of courser pitch and less area and less revolutions per minute will give almost as good results for speed as a towing propeller of high revolutions per minute; and the lesser revolutions per minute of the courser pitch propeller results in a saving in wear and tear of the machinery.

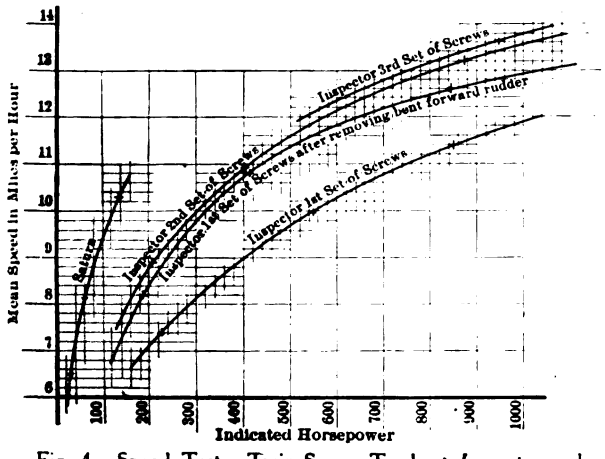
Mean Speed in Miles per Hour
Indicated Horsepower
Inspector 3rd Set of Screws
Inspector 3rd Set of Screws after removing bent forward rudder
Inspector 2nd Set of Screws
Inspector 1st Set of Screws
Saturn

Fig. 4.—Speed Test. Twin-Screw Towboat *Inspector* and Sternwheel Towboat *Saturn*

The apparent slip reduces with a decrease of the pitch and an increase of the area in our case from almost 30 percent to almost 20 percent.

The thrust of the screw is constant at each revolution per minute, and not fluctuating as in a sternwheel boat.

A properly designed tunnel towboat drawing 4 feet can possibly be designed to generate 1,500 indicated horsepower with a possible thrust of 30,000 pounds.

The test of the sternwheel towboat *Wynoka* allows us to make the following deductions:

Deductions from Tests of Sternwheel Towboat "Wynoka"

The thrust per bucket area increased very rapidly with the increase of the circumferential speed.

A circumferential speed of 1,500 feet per minute and more is desirable.

Each square foot of bucket area can absorb 13 to 15 indicated horsepower and produce a thrust of 300 to 350 pounds.

The thrust fluctuating as much as 15 percent either way even with almost constant revolutions per minute.

A sternwheel towboat of 600 indicated horsepower is in pushing power equal to a tunnel towboat of 900 indicated horsepower.

A sternwheel towboat of 1,000 indicated horsepower might in pushing power be equal to a tunnel towboat of 1,500 indicated horsepower, both drawing not more than 4 feet.

The tests of the sternwheel towboat *Saturn* allow us to make the following deductions:

Deductions from Tests of Sternwheel Towboat "Saturn"

The thrust per indicated horsepower rapidly decreases with the increase of the indicated horsepower.

The thrust per indicated horsepower is greater in a small boat than in a large boat.

Conclusions

The tests give us a right for the following conclusions:

Five hundred and eighty-seven indicated horsepower produced in the sternwheel towboat *Wynoka* 190 effective horsepower, or 32.4 percent plant efficiency.

Nine hundred and seventy-nine indicated horsepower produced in the tunnel towboat *Inspector* 202 effective horsepower, or 20.7 percent plant efficiency.

Or the sternwheel power transmission was superior to the tunnel screw transmission by 57 percent.

On the other hand, the tunnel towboat type carries three indicated horsepower per ton of displacement against the sternwheel towboat's one and one-half, or twice as much.

And the tunnel towboat should have a superior fuel economy to the sternwheel towboat owing to the use of triple-expansion engines, or possibly fuel oil engines, which are particularly well adapted for the direct propeller drive.

As a general rule, one might say that a sternwheel towboat of 600 indicated horsepower is equal to a tunnel towboat of 900 indicated horsepower in pushing power, but inferior in speed and inferior in fuel economy. On the other hand, the sternwheel boat is cheaper in construction, due to the peculiar condition of the shipyards on Western rivers, which are not acquainted with the construction of tunnel towboats, but well acquainted with the construction of the sternwheel type of towboat.

Regarding the construction of larger tunnel towboats, the tests have demonstrated that 1,300 indicated horsepower could be absorbed efficiently in two 5 feet 6 inches diameter screws and that a 1,500 indicated horsepower tunnel towboat, and even a 2,000 indicated horsepower

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tunnel towboat drawing 4 feet of water, are in the realm of possibilities.

The sternwheel towboat can always hold its own in competition with the tunnel towboat up to a certain horsepower, owing to cheaper hull construction, cheaper machinery and smaller investment in engine horsepower. The future sternwheel towboats should, however, strive after higher revolutions per minute with corresponding increase of circumferential speed, increase of bucket area and increased fuel economy.

With an increase in channel depth, however, the tunnel towboat type gains quickly in superiority over the sternwheel towboat type. Not only does the ratio of effective horsepower to indicated horsepower grow quickly, but the hull dimensions decrease rapidly in the tunnel towboat type as the draft increases, so that the writer believes that it would be unadvisable to build any more sternwheel towboats of larger power, such as the 2,000 horsepower *Sprague*. It is preferable to build tunnel towboats of considerably smaller dimensions and equally effective pushing power and considerably superior fuel economy and smaller operating cost.

The question of handling ability is purposely not touched upon. It should be considered separately and individually.

Port of Astoria Steamship Terminal

New System of Municipal Docks with Coaling Facilities, Grain Elevator and Freight Piers Developed at Astoria

BY J. P. NEWELL *

THE port of Astoria decided in the early part of 1914 to construct a system of municipal docks, with coaling facilities, grain elevator and other means of caring for ocean traffic as needed. A tract of about 60 acres, with a deep water frontage of 1,850 feet, was purchased, and the firm of which the writer is a member was employed to design and construct the works.

Since the greater part of the tract lay below mean low water, a system of piers and slips was the natural form of development. The effect of the tides is felt along the Columbia River over 100 miles inland. The immense volume of water thus set in motion, together with the natural flow of the river, produces strong currents which on the ebb sometimes reach four miles per hour.

The first problem confronting the engineers was the location of slips which could be safely and easily entered at any stage of the tide. Satisfactory results have been obtained by placing Slip No. 1 at an angle with the stream of about 50 degrees and making it 400 feet wide at the entrance and 250 feet at the rear end. The adjacent waterfront is not yet built upon, consequently the tides running in either direction now form an eddy in front of the slip, so that vessels enter or leave without the slightest difficulty. The eddy will probably disappear when the adjoining property is filled in to the bulkhead line, but it is believed that the shape and location of the slip will prevent trouble at any time. The dimensions of Slip No. 2 will depend somewhat on the plans of those owning the land on the west side of it, but these plans will be subject to the approval of the Port Commission and

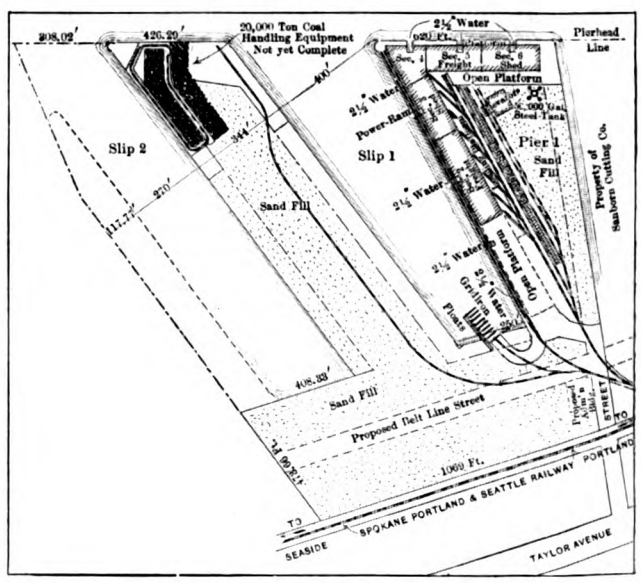

Fig. 2.—General Plan Astoria Piers

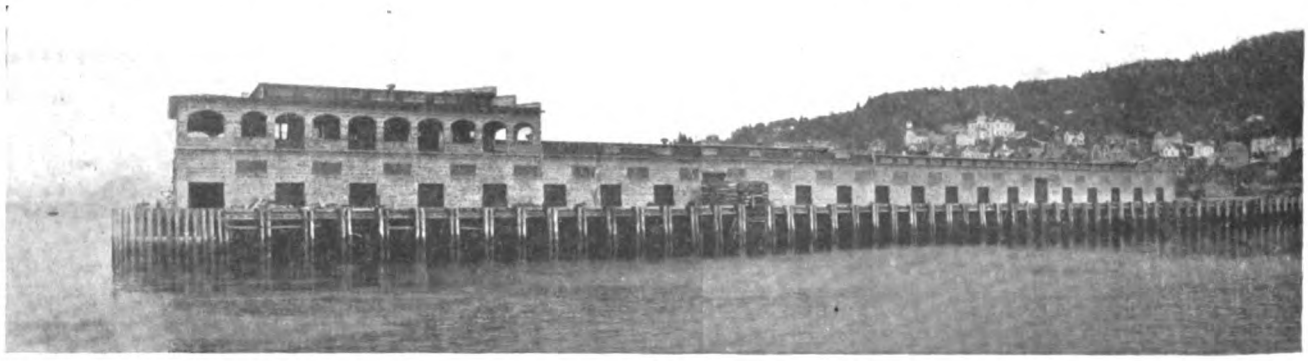

Fig. 1.—Pier No. 1 Nearing Completion

* President of Newell, Gossett & Walsh, civil engineers, Portland, Ore., and president of the Portland, Oregon, Association of Members of the American Society of Civil Engineers.

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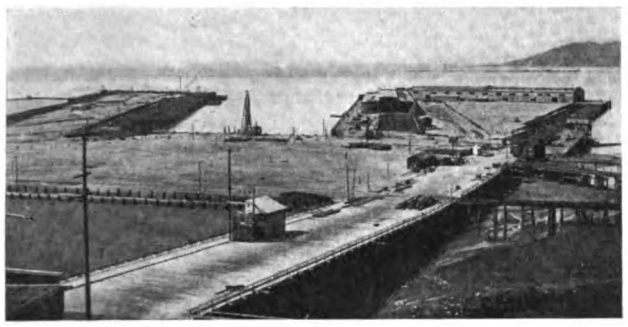

Fig. 3.—General View of Municipal Docks

they will be guided by the experience gained with the present construction.

GENERAL TYPE

The general type of construction is a pile and timber pier enclosing a sand fill kept in place by timber lagging against the piles, with riprap in exposed places. The building is of wood except the walls, which are of Denison interlocking hollow tile with reinforced concrete columns supporting the roof trusses. Steel roller doors and windows with steel sash set directly in the tile work are used

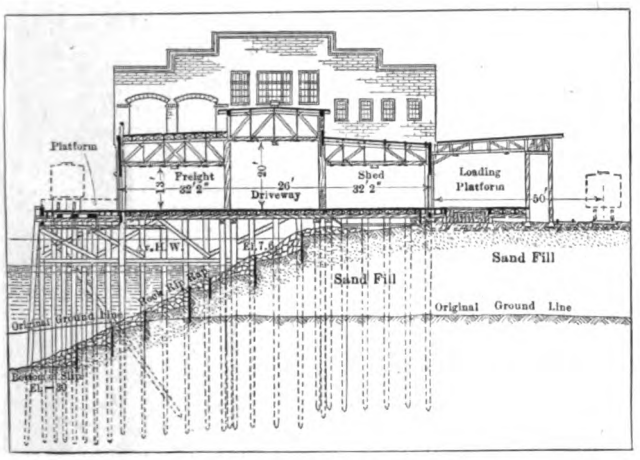

Fig. 4.—Cross-Section, West Side Pier No. 1

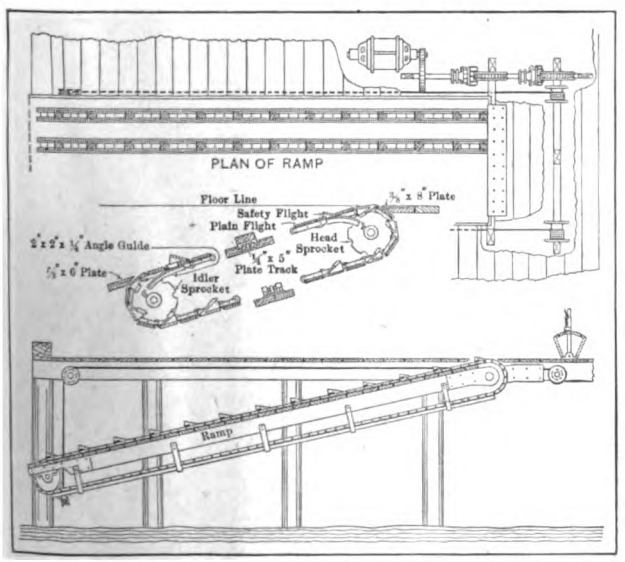

Fig. 5.—H and U Safety Booster for Astoria Piers

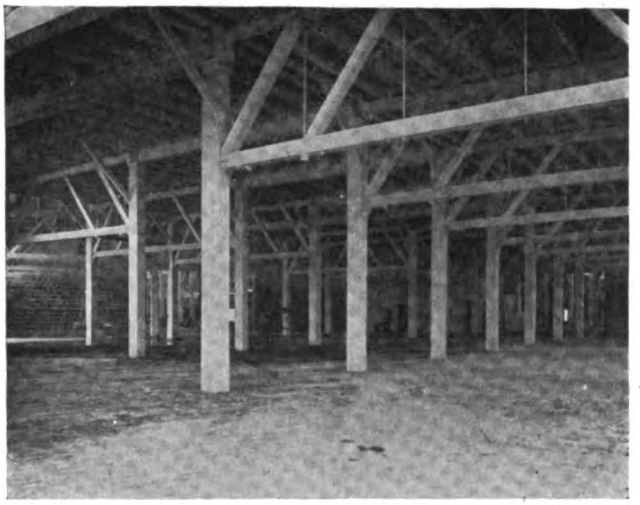

Fig. 6.—Interior of Pier Shed

throughout. Continuous monitor windows and the use of white paint on the interior give exceptionally good light. Interior posts supporting the roof have been used with considerable economy and have been found to cause no inconvenience.

FREIGHT HANDLING

No crane equipment has yet been provided, reliance being placed for the present on ships' tackle, but the front platform is wide enough for a gantry crane with one leg on the roof and the other on the edge of the wharf. It is planned to use dock trucks, but they have not yet been installed.

ADJUSTABLE RAMPS

Six slips have been provided with adjustable ramps for the handling of freight to and from river boats and barges. The ramp platforms have been equipped with a special booster chain to carry the loaded trucks up the incline. Two flat top chains are used, running on rollers in guides spaced to suit the hand trucks in use on the dock. Sprocket wheels mounted on the hinge shaft drive the chains, which have semi-attached steps which engage the truck wheels until the top of the incline is reached,

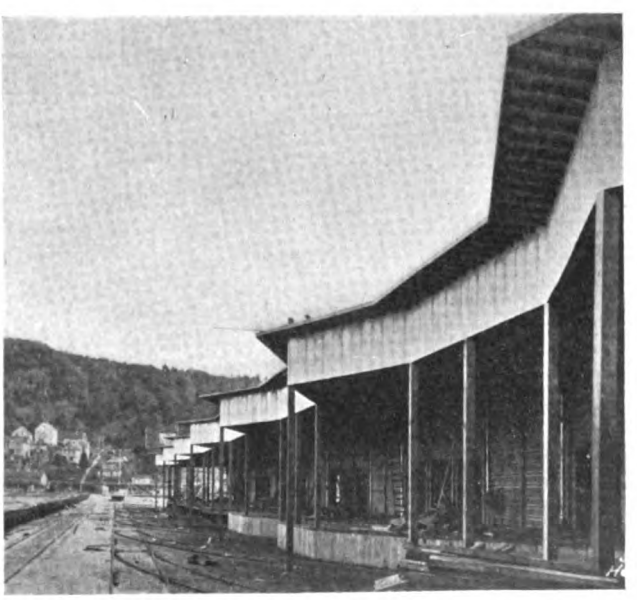

Fig. 7.—"Herring-bone" System of Tracks Leading to Pier Shed

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UNION OIL COMPANY'S TANK STEAMER LA BREA

Built by Union Iron Works Company

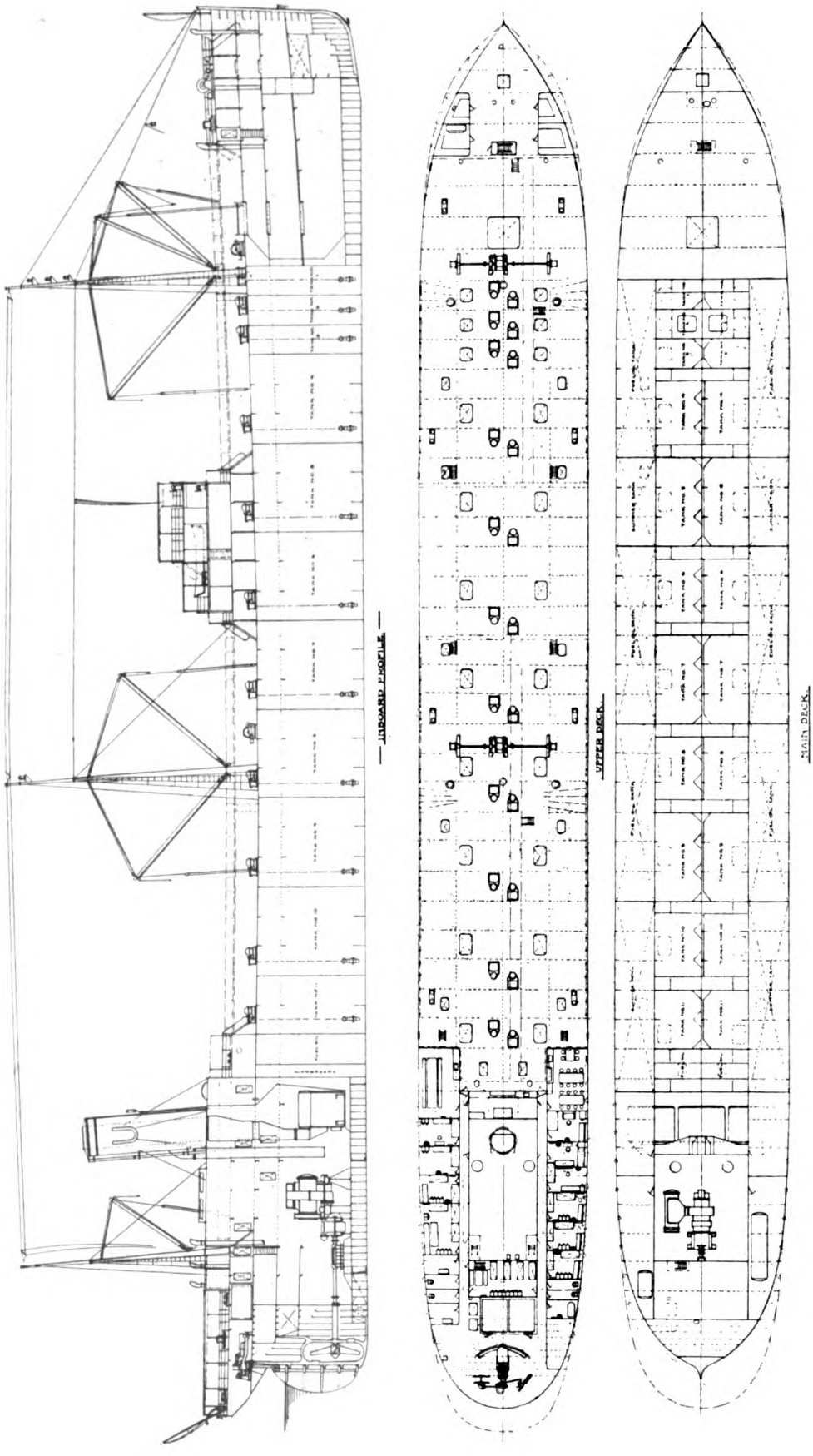

Fig. 1.—Inboard Profile and General Arrangement Plans of Upper and Main Decks

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when they drop automatically and pass through the opening in the floor with a clearance of less than one-fourth inch.

The railroad tracks are carried across the slips by movable platforms that are raised and suspended above the openings when the slips are in use. All these operations are performed by means of a 7½ horsepower A. C. motor placed under the dock floor, and controlled by a drum-type controller with reversing handle connected with reversing variable speed motor. The three levers controlling the various operations are interlocking and engage friction clutches under the dock floor. The cost of a ramp complete, with steel trussed beams and all mechanical and power equipment, was $3,000 (£615).

Three rails have been laid along the front of the dock, so spaced that the center one can be used with either of the others. Cars can thus be set close to the edge for unloading freight into chutes or at a sufficient distance back to permit skips to be landed in front of the cars. This gives most of the advantages of double track with less space and a shorter distance for trucking the freight which goes through or into the warehouse.

The "Herring-bone" system of tracks in the rear is specially designed for quick handling of cars. It consists of a series of short parallel spurs, each holding two cars and running diagonally into the freight platform. The cars are entirely under the shed roof, which is important in a wet climate like that of Astoria. The platform is on a level with the car floors, and the end car on each spur can be reached from either side. Three cars can be reached from any one door of the warehouse, making it possible to close alternate doors and use the space in front of them for storage. Electric light plugs are provided along the wall so that connections can readily be made for lights in the cars. The cars on any spur can be moved without disturbing any other, which greatly facilitates switching, especially when handling L. C. L. freight.

The contractors were: J. A. McEachern Company, of Seattle, for the substructure; C. L. Houston, of Astoria, for the superstructure; Tacoma Dredging Company for the dredging and filling. Helser & Unden, of Portland, designed and constructed the booster. F. J. Walsh, of Newell, Gossett & Walsh, Portland Ore., was chief engineer; R. R. Bartlett, assistant engineer in charge of designing; and K. E. Hodgman, assistant engineer, in charge of field work.

Oil Tank Steamer La Brea*

Electric Pumping Equipment and Performance of Reduction Gear Turbines on New Tank Steamer for Union Oil Company

BY HUGO P. FREAR

The S. S. *La Brea* is the first tank steamer equipped with independent submerged cargo pumps in each compartment, port and starboard, operated by electric motors on deck, and also the first to be fitted with reduction gear turbines, so far as the writer knows. Otherwise the vessel differs little from many tankers built on the Isherwood longitudinal system of framing, and therefore these two items, especially the electric pumping system, will receive the most attention.

The *La Brea* is 435 feet in length, 56 feet in breadth and 33 feet 6 inches in depth, molded, and was the first vessel of this particular class built by the Union Iron Works Company, San Francisco. The contract was dated May 14, 1915, and delivery made February 29, 1916.

There have since been completed or contracted for by the same builders thirteen additional tankers off the same scrieve, all with pump rooms and ordinary pumping systems except one vessel for the Pan-American Petroleum Transportation Company, which will have the same pumping system as the *La Brea*, but with only one pump to each transverse cargo compartment in lieu of two, as fitted on the *La Brea*.

Ten of these additional tankers have reduction gear turbines and three triple expansion reciprocating engines of approximately the same indicated horsepower as the shaft horsepower of the turbines. In each case the length of

* Extract from paper read before the Society of Naval Architects and Marine Engineers, New York, November, 1916.

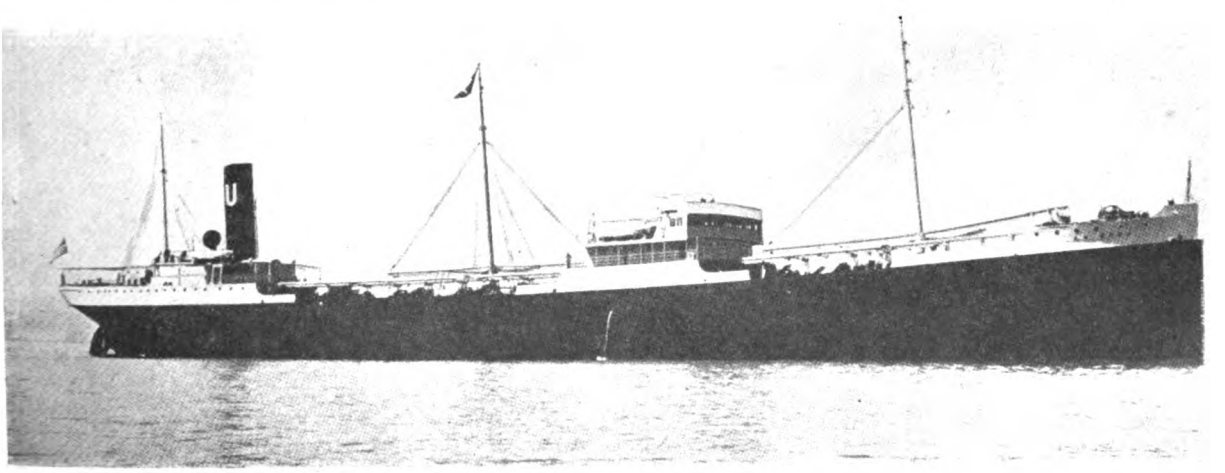

Fig. 2.—S. S. *La Brea* in Ballast Trim

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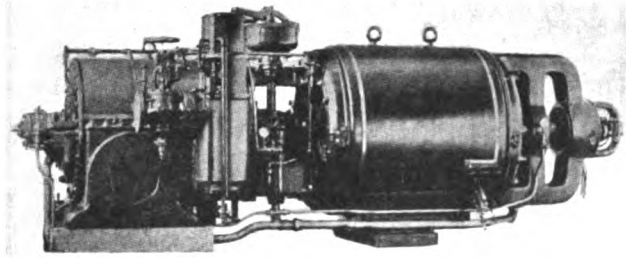

Fig. 3.—Turbo Generating Set

machinery space, forehold and overall length of the oil compartments, including pump room and cofferdams, are the same. The position of the pump room, cofferdams, length of fuel tank and length of some of the cargo tanks vary more or less to suit the owners' views.

Of this class, the tanker following the *La Brea* was the *Los Angeles,* also for the Union Oil Company, of California, but fitted with triple expansion reciprocating engines, pump room and ordinary pumping equipment of standard capacity and efficiency. These two vessels, delivered within a month of each other and owned and operated by the same company, offer a most excellent opportunity for a comparison of their performances on the voyages so far completed.

The propulsion equipment of *La Brea* was furnished by the General Electric Company and consists of a Curtis turbine of the type developed for ship propulsion work, operating at a speed of 3,500 revolutions per minute, direct connected to a double reduction gear suitable for reducing the speed of the turbine to 90 revolutions for driving the propeller. The normal rating of the turbine and gear is 2,600 brake horsepower, with a steam pressure of 200 pounds at the throttle valve, 50 degrees superheat and exhausting into a vacuum of 28½ inches, measured at the exhaust inlet with the barometer at 30 inches. The complete weight of the turbine and reduction gear, including all parts for the throttle valve and thrust shaft coupling, is about 110,000 pounds.

The electric cargo pumping system consists of twenty-two Ideal 4-inch rotary pumps built by the Union Tool Company, Torrance, Cal. They are designed especially

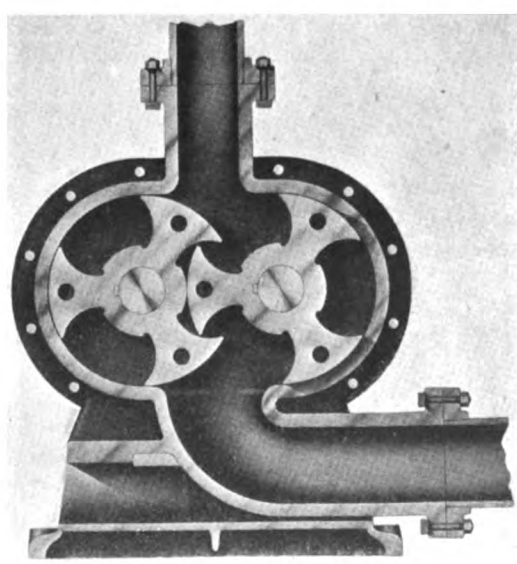

Fig. 4.—4-Inch Ideal Rotary Pump Rotors

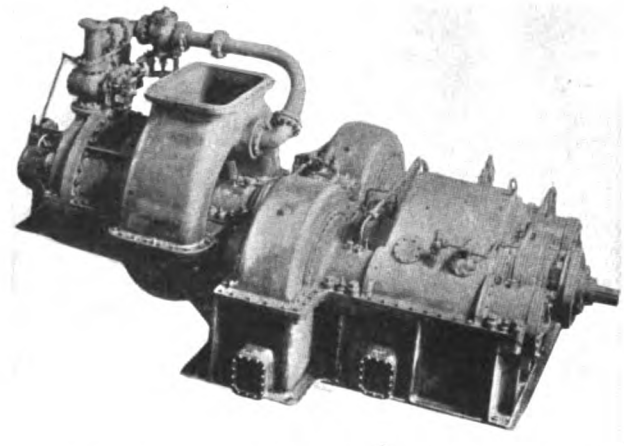

Fig. 5.—Assembled Reduction Gear—Turbine 2,600 Shaft Horsepower

for handling highly viscous oils, molasses and creosote, and are also fitted with a steam jacket for handling asphaltum. Each pump can deliver 350 gallons per minute against a total head of 350 feet at 200 revolutions per minute. The pumps are secured in the bottom of each compartment of the vessel, port and starboard to brackets that are integral with the tanks, and are driven by 40-horsepower, three-phase, 60-cycle, 220-volt motors. The discharge line for the three small tanks forward have nine 4-inch discharge gates, while the separate discharge line for the remaining tanks have fourteen 6-inch discharge gates.

The motors are located on the upper deck contained in a watertight and gas proof casing. The drive to the pumps is through a set of bevel reduction gears and a vertical shaft which transmits the power through flexible couplings to the pumps. The shaft is entirely enclosed in a casing which serves as an oil reservoir, so that all of the shaft

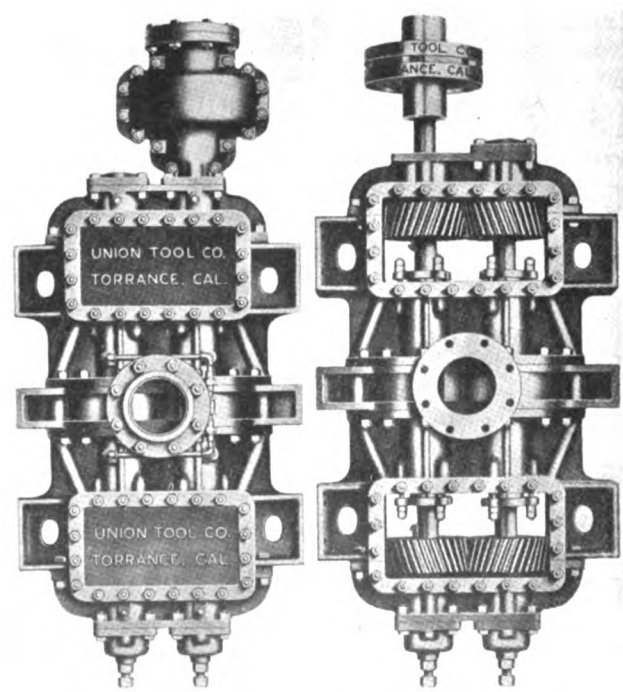

Fig. 6.—Exterior and Interior Views of 4-Inch Ideal Rotary Pump

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bearings and the pump gears are all operated in an oil bath.

The pumps are each fitted with enclosed carbonized spiral gears, top and bottom, and operated with a minimum of noise. The vertical-drive shaft is hung on a ball thrust bearing contained in the gear case. They are fitted with 6-inch suctions and 6-inch discharges, so arranged that each pump can take suction from either or both compartments, port and starboard, at the same time, or independently. Cargo may also be discharged with one pump

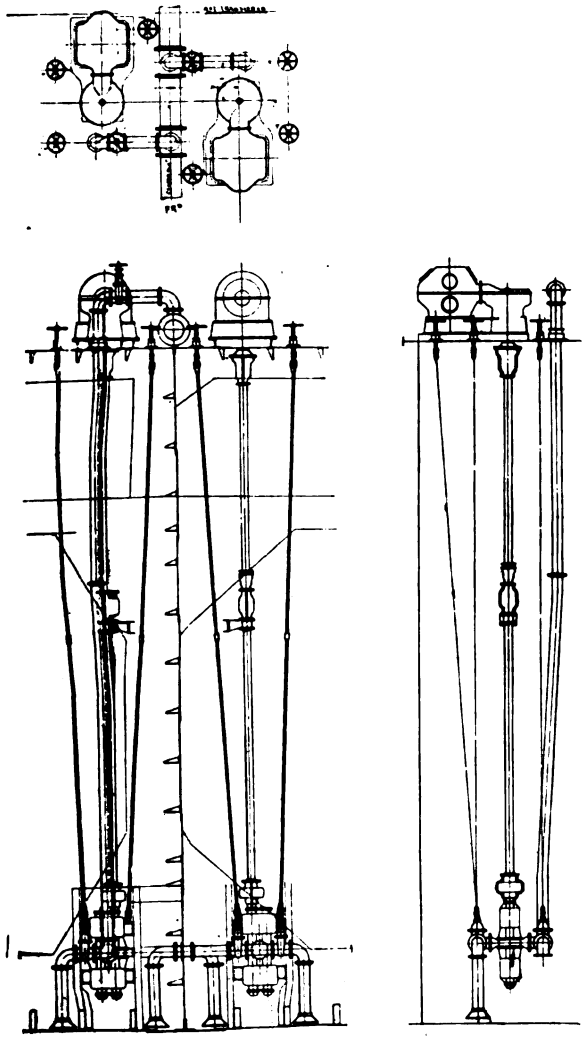

Fig. 7.—Details of Pump Installation, Showing Location of Pumps, Driving Motors and Method of Driving

or as many pumps as can be put into operation at one time, depending entirely on the capacity of discharge pipes to the shore tanks. Any number of commodities can be discharged at the same time without mixing, depending, of course, on the number of discharge lines that are available to the shore tanks. The discharge lines from the pumps are so arranged that they can be also used as filling lines to each individual tank, by means of a bypass around the pump.

All operating valves are located on the upper deck. The motor control for starting the pumps is located in the main engine room, and when it is desired to start any particular pump the deck officer gives the signal to the operator in the engine room. Pumps are thus under direct control at all times by the engineer on watch.

Since the *La Brea* went into commission she has handled

TABLE I.—*S. S. La Brea.*

Voyage	Date	Distance	Average speed per hour	Delivered	Port	Fuel used steaming on voyage	Per knot steaming	Used in port	Per knot steaming and in port	Time in port	Discharged per hour	Cost*
		Knots	Knots	Barrels		Barrels	Barrels	Barrels	Barrels	Hours	Barrels	
1	Mar. 9 to Mar. 15	650	9 5	62, 578	Oleum	574	.883	142	1.10	36½	1, 714	880
2	Mar. 15 to March 26	2, 037	11 33	73, 600	Seattle	1, 459	.716	152	.790	37½	1, 962	632
3	Mar. 28 to Apr. 6	2, 108	11 01	64, 676 8, 642	Vancouver Seattle	1, 584	.751	156	.824	26 13½	2, 487 640	659
4	Apr. 8 to May 16	9, 254 5	10 97	82, 109 9, 045	Taltal Antofagasta	6, 896	.745	117	.757	33 K 15½	1, 544 1, 228	605
5	May 17 to May 23	660	11.2	77, 292	Oleum	321	.713	134	1.01	39	1, 980	808
6	May 24 to July 1	9, 196 5	10 65	71, 824	Antofagasta	6, 900	.750	109	.762	25	2, 680	609
7	July 1 to Aug 9	9, 184	10 39	71, 791	Antofagasta	6, 875	.748	107	.760	31	2, 316	610
Total		32, 880	10.72	501, 557		24, 609	.748	916	.776		2, 418	621

*At 80 cents per barrel per knot steaming and in port (full).

TABLE II.—*S. S. Los Angeles.*

Voyage	Date	Distance	Average speed per hour	Delivered	Port	Fuel used steaming on voyage	Per knot steaming	Used in port	Per knot steaming and in port	Time in port	Discharged per hour	Cost*
		Knots	Knots	Barrels		Barrels	Barrels	Barrels	Barrels	Hours	Barrels	
1	Apr. 9 to Apr. 15	423	9.4	67, 074	Oleum	556	1 31	164	1 70	64½	1, 039	1 36
2	Apr. 16 to Apr. 25	1, 845	10.13	74, 739	Vancouver	1, 656	.897	218	1.01	33½	2, 214	808
3	Apr. 27 to May 25	6, 549	10.22	73, 734	Panama	5, 679	.851	169	.877	46½	1, 577	701
4	May 26 to May 29	220	9.1	72, 592	Oleum	221	1 00	123	1.56	41	1, 770	1 24
5	May 30 to June 27	6, 348	10.6	72, 538	Balboa	5, 462	.860	159	.885	35	2, 072	708
6	June 29 to Aug. 7	9, 151	10.24	71, 007	Antofagasta	8, 293	.906	186	.926	56½	1, 261	741
Total		24, 886	9.96	431, 684		21, 767	887	1019	928		1, 866	723

*At 80 cents per barrel per knot steaming and in port (full).

over 500,000 barrels of oil, and in each case the discharge was completed with a material saving in time as compared with vessels with ordinary pumping system.

The capacity of the pumping system is, of course, regulated by the capacity of the discharge lines and the pressure that the pumps are subject to. On a low-discharge head, and with ample shore connections, the entire cargo could be discharged in approximately 10 hours' time. The maximum quantity of oil handled per hour against a pressure of 110 pounds per square inch is reported to be 4,200 barrels.

The economy in fuel saved with this pumping installation appears to be approximately 45 percent over the ordinary manner of discharging a liquid cargo.

The data in Tables I and II have been compiled from logs on voyages to date, respectively, for the *La Brea* and *Los Angeles* and give a very good general idea of the

TABLE III.—*Voyage 7, S. S. La Brea Compared with Voyage 6, S. S. Los Angeles.*

	La Brea July 1 to August 9		*Los Angeles June 29 to August 7*	
Total distance steamed in knots	9,184		9,151	
Average knots per hour throughout voyage	10.39		10.24	
Average revolutions per minute	85.75		65.94	
Average vacuum	28.61		26.72	
Steaming time loaded and light	36 days, 16 hrs., 50 min.		37 days, 5 hrs., 6 min.	
Fuel used steaming loaded and light	6,875	bbls.	8,293	bbls.
Fuel used per knot steaming	.748	bbls.	.906	bbls.
Fuel used in port pumping	107	bbls.	186	bbls.
Fuel used steaming and in port	6,982	bbls.	8,479	bbls.
Fuel used steaming and in port per knot	.760	bbls.	.926	bbls.
Cargo discharged	71,791.13	bbls	71,007	bbls.
Time discharging	31	hrs.	56 hrs. 17	min.
Average barrels per hour discharged	2,315 84		1,261.	

	Per cent less	*Per cent greater*
Percentage less or greater fuel used steaming	17.09	20.6
Percentage less or greater fuel used in port	42.47	73.8
Percentage less or greater time in port discharging	44 92	81 5
Percentage less or greater fuel per knot steaming	17.43	21.13
Percentage less or greater fuel per knot steaming and in port	17.92	21.84

	Per cent greater	*Per cent less*
Percentage greater or less barrels pumped per hour	83.65	45 54

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comparative performances of the two vessels and their equipment. The methods employed by companies in measuring oil into and out of a vessel sufficiently guarantee the accuracy of these data for general comparison.

Comparing the time in port discharging and barrels of oil discharged per hour for the first six voyages, the *La Brea* was in port 36.4 percent less time and discharged 55.4 percent more oil per hour than the *Los Angeles*. If we reverse the order it will be noted that the *Los Angeles* was in port 57.04 percent more time and discharged 35.67 percent less oil per hour than the *La Brea*.

By referring to voyage seven of the *La Brea* and voyage six of the *Los Angeles*, it will be observed that the destination in each case was Antofagasta, Chili, and that the Los *Angeles* preceded the *La Brea* by two days. Notwithstanding the *La Brea* had been out of dock a month longer than the *Los Angeles* and a greater time in warm water, it is stated that she could have overhauled the *Los Angeles* and discharged first had the contrary not been arranged.

Table III gives separately a comparison of these two voyages on which the weather conditions are reported as follows:

La Brea.—July 1 and 2, rough following sea; July 3 to 7, fine weather; July 8, rough; July 9 to 12, fine weather; July 13 to 22, strong head wind and sea; July 23 to 30, fine weather; August 1 to 9, strong southwest wind and sea.

Los Angeles.—June 29 to July 5, fine weather; July 6 to 10, fresh head wind and sea; July 14 to 17, strong head wind and sea; July 18 to 28, fine weather; July 29 to August 7, moderate head wind.

It will be noted that the *La Brea* consumed 17.09 percent less fuel steaming, 42.47 percent less fuel in port, 44.92 percent less time in discharging, 17.43 percent less fuel per knot steaming, 17.92 percent less fuel per knot steaming and in port, and discharged 83.65 percent more barrels of oil per hour.

Mono Marine CO_2 Recorder

Flue gas analyses in connection with the operation of marine steam boilers to determine the efficiency of combustion can be made either by hand or automatically. Hand instruments are cheap, but, as the name implies, they are operated by one of the engineers on watch, who enters the analyses into the log sheet. The human element is not always dependable, neither does the time and length of watch always permit regularity of taking analyses. For this reason the Mono Marine CO_2 recorder for flue gas analysis, which is illustrated herewith, and which is handled in the United States by F. D. Harger, 603 Park Row Building, New York City, will be of interest to marine engineers, as it has been designed solely for use on board ship.

The United States Navy Department has experimented extensively in the analysis of flue gases, and, as a consequence, hand instruments are to be found on every battleship in the United States Navy, and, in fact, such instruments have become a part of the standard naval boiler room equipment. Very careful tests have been conducted on sister ships of the same boiler capacity, tonnage, dimensions, etc., one vessel being equipped with an instrument for analyzing the flue gases, and the other not so equipped. On the ship equipped with the analysis instrument the consumption of coal at the end of the trip was found to be considerably less than that of the non-equipped ship. As a result of these tests, experiments with recording instruments were begun, but these experiments ceased when it was found that none of the instruments commonly used in stationary practice would stand hard sea service. The Mono Marine CO_2 recorder, however, has now been offered to the Government, and experiments will soon be conducted on the United States battleship *Nevada*. As a result, it is expected that a large amount of fuel can be saved on board the ship by use of these instruments, just as has been established by their use on shore.

Fig. 1.—Marine Mono, with Moisture Regulator

As shown in Fig. 1, the Mono CO_2 recorder is suspended in a universal joint to permit the instrument to follow the movement of the ship as well as to counteract the bad effects of vibration. Fig. 2 shows part of a record, including a CO_2 as well as a CO diagram, both on one chart, made by the Mono apparatus. It will be seen that a very clear and even record has been obtained. Four of these Monoxide-CO_2 recorders have been installed on board of the S. S. *Kristianiafjord*, and, judging from the fact that the owners of the vessels, the Norwegian-American Line, placed the vessel in operation six months ago with one recording instrument on board and has since installed three more instruments, it is evident that the recorders have been successful and have attained the savings that were claimed by the manufacturers.

In this particular case, the furnaces of the boilers were equipped with Wager bridge walls, as manufactured by Robert H. Wager, 149 Broadway, New York. It was found that with a high percentage (from 11 to 12 percent) of CO_2 carbon monoxide to the extent of one percent was present, resulting in fuel loss, while, on the other hand, with Babcock & Wilcox watertube boilers, when the CO_2 averaged around 10 percent hardly any monoxide was present, indicating ideal conditions of combustion. In this way the firemen learned just what percentage of CO_2 to carry, something which could not be learned without an instrument recording the percentages of CO_2 and CO.

Figs. 4 and 5 show two views of one of the furnaces. Fig. 4 shows the appearance of the firebrick bridge after a run of 4,000 miles, indicating considerable fuel loss due

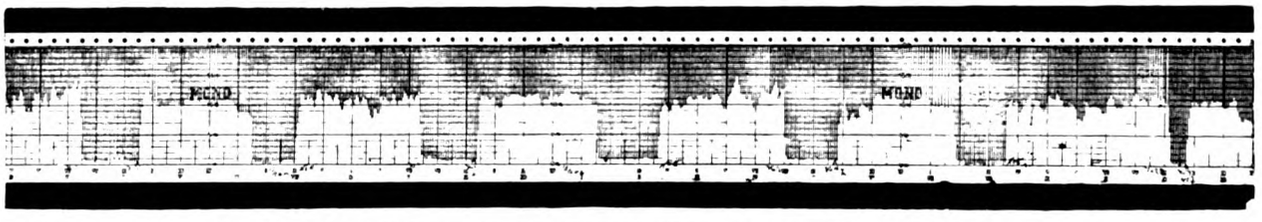

Fig. 2.—Part of Record Made by Mono Apparatus, Showing CO_2 and CO Diagrams

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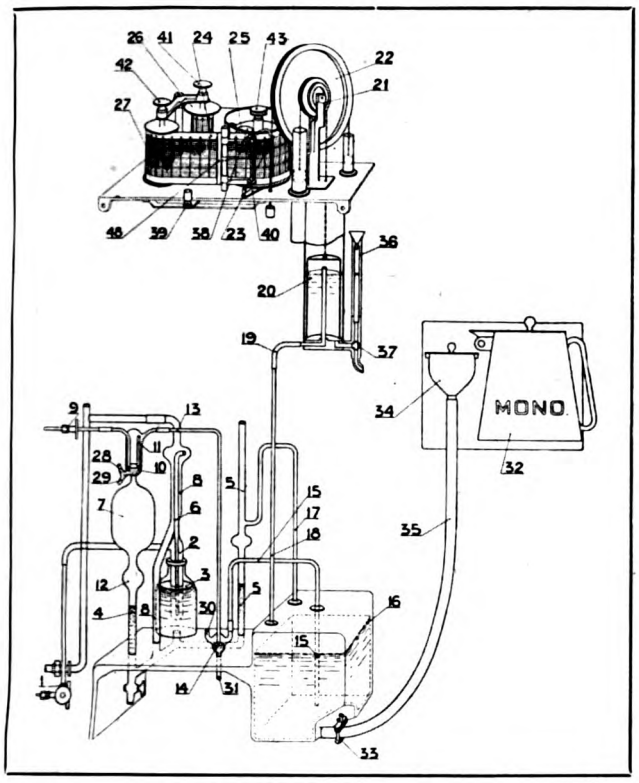

Fig. 3.—Diagram of Apparatus

Fig. 6.—View Showing Interior of Recorder

to the presence of monoxide, forming on account of lack of air. Fig. 5, on the other hand, shows the Wager bridge in position, and from the records given by the CO_2 recorder it is easy to see how well it serves the purpose, as its design allows for the entrance of additional air to mix with the products of combustion, thus giving almost complete combustion of the fuel. The photograph shows no traces of deterioration after a run of 40,000 miles.

The proper distribution of air is what is indicated by the Mono apparatus: for, as is well known, combustion is a chemical process, during which a certain amount of oxygen combined with a suitable proportion of carbon under high temperature results in the formation of CO_2 gas. If at all times the amount of this gas present in the flue gas is known, it is evident that the conditions of combustion are in no sense a matter of guesswork, but, on the other hand, there is available a complete and reliable "tell-tale" record by which to fire the boilers.

The Mono recorder operates as follows: The absorption apparatus is mounted in the lower part of the cast-iron cabinet, to which it is fastened by means of three screws in the bottom. The pressure medium (water or air) by which the apparatus is driven passes through the regulating valve 1, Fig. 3, and the pipe, 2, into flask 3, which contains mercury. This is compressed up into the pipes 4, 5, 6 and 8.

Pipe 4 is at the top connected with the burette, in which

(*Continued on page 74.*)

Fig. 4.—Appearance of Furnace After 4,000-Mile Run Before Equipment Was Installed

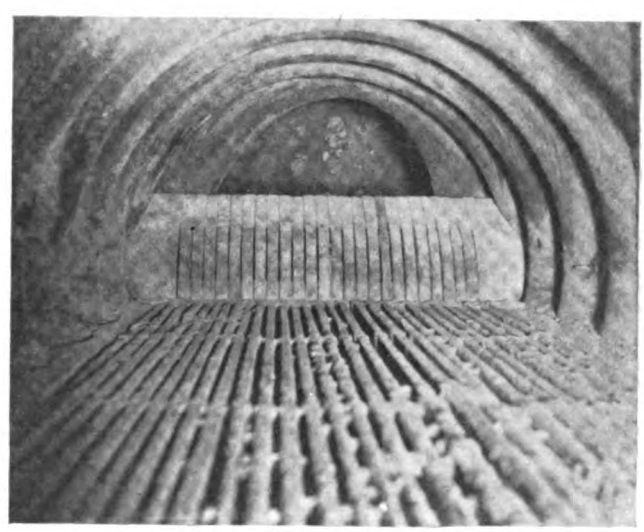

Fig. 5.—Condition of Furnace After 40,000-Mile Voyage, with Wager Bridge Wall and Mono Apparatus Installed

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TURBINE STEAM YACHT WINCHESTER—TRIAL SPEED, 31.56 KNOTS

Built by Bath Iron Works, Bath, Me.

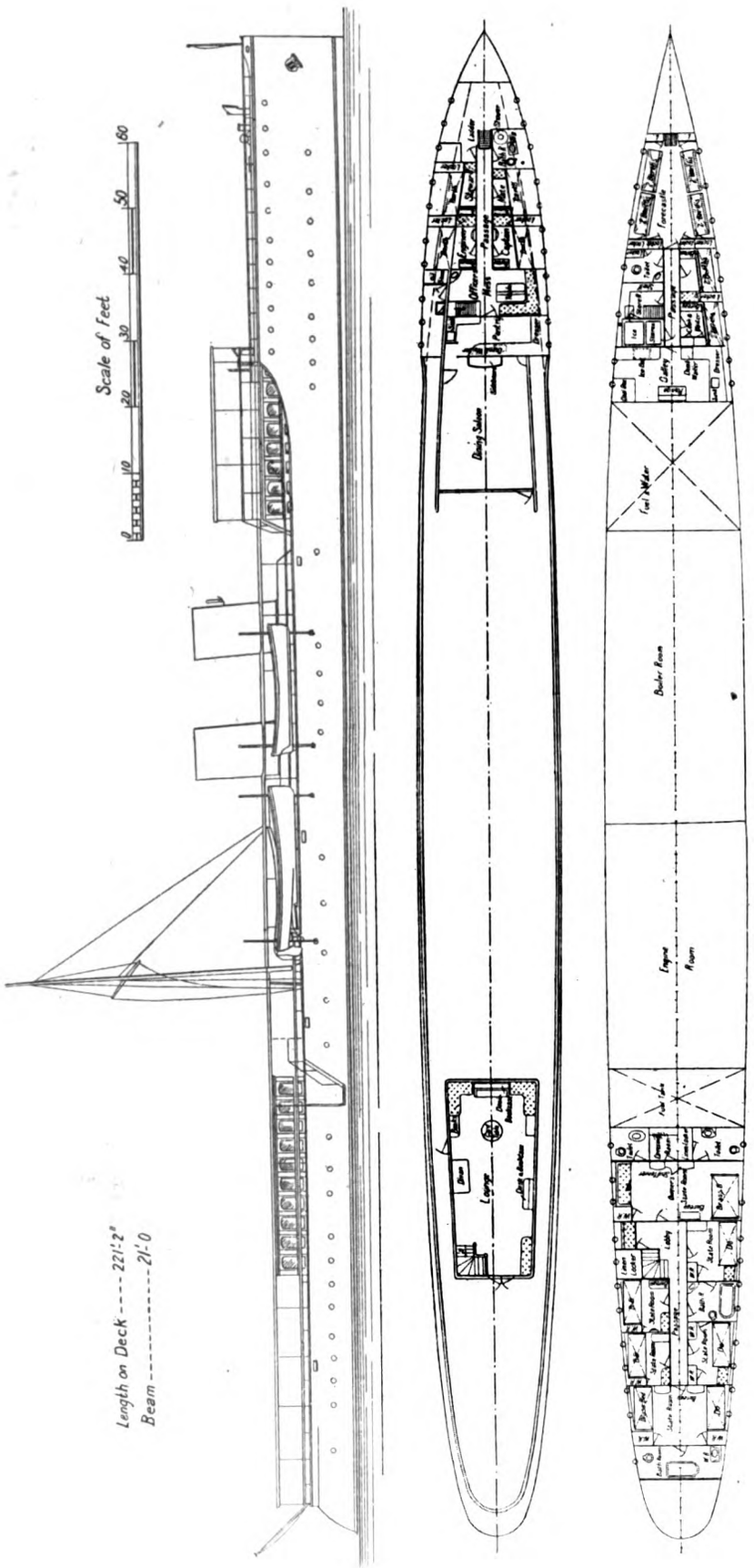

Fig. 1.—S. S. *Winchester*—General Arrangement Plans

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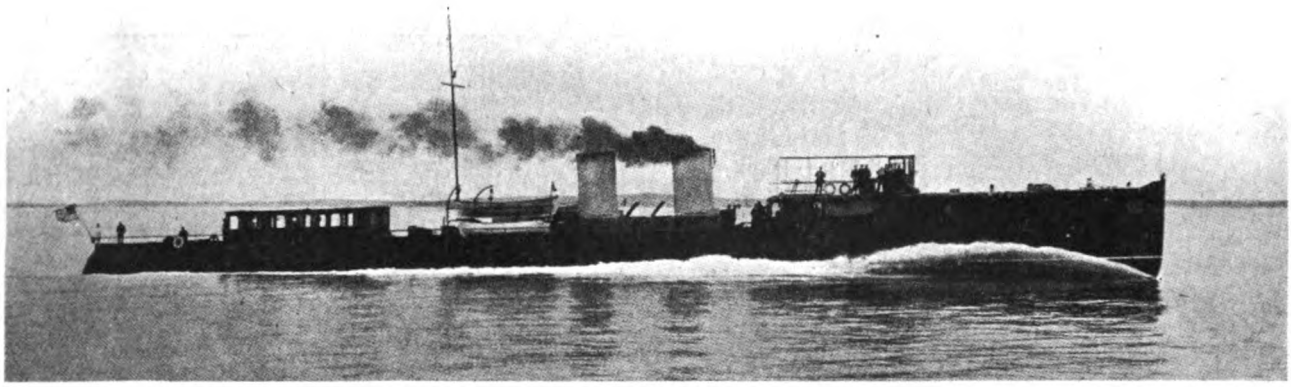

Fig. 2.—Steam Yacht *Winchester* on High-Speed Run, Trial Trip, Showing Thin Bow Wave

Turbine Steam Yacht Winchester

Main Particulars and Trial Data of 30-Knot Yacht Designed by Cox & Stevens

BY E. A. STEVENS, JR.

THE steam yacht *Winchester* is the fourth vessel built for Mr. P. W. Rouss to bear that name. Like all her predecessors, she was built primarily for speed, but is considerably larger than her predecessors; in fact, she is the largest high-speed steam yacht ever built.

The *Winchester* is a twin-screw vessel, fitted with Par-

* From a paper presented before the Society of Naval Architects and Marine Engineers, New York, November 16.

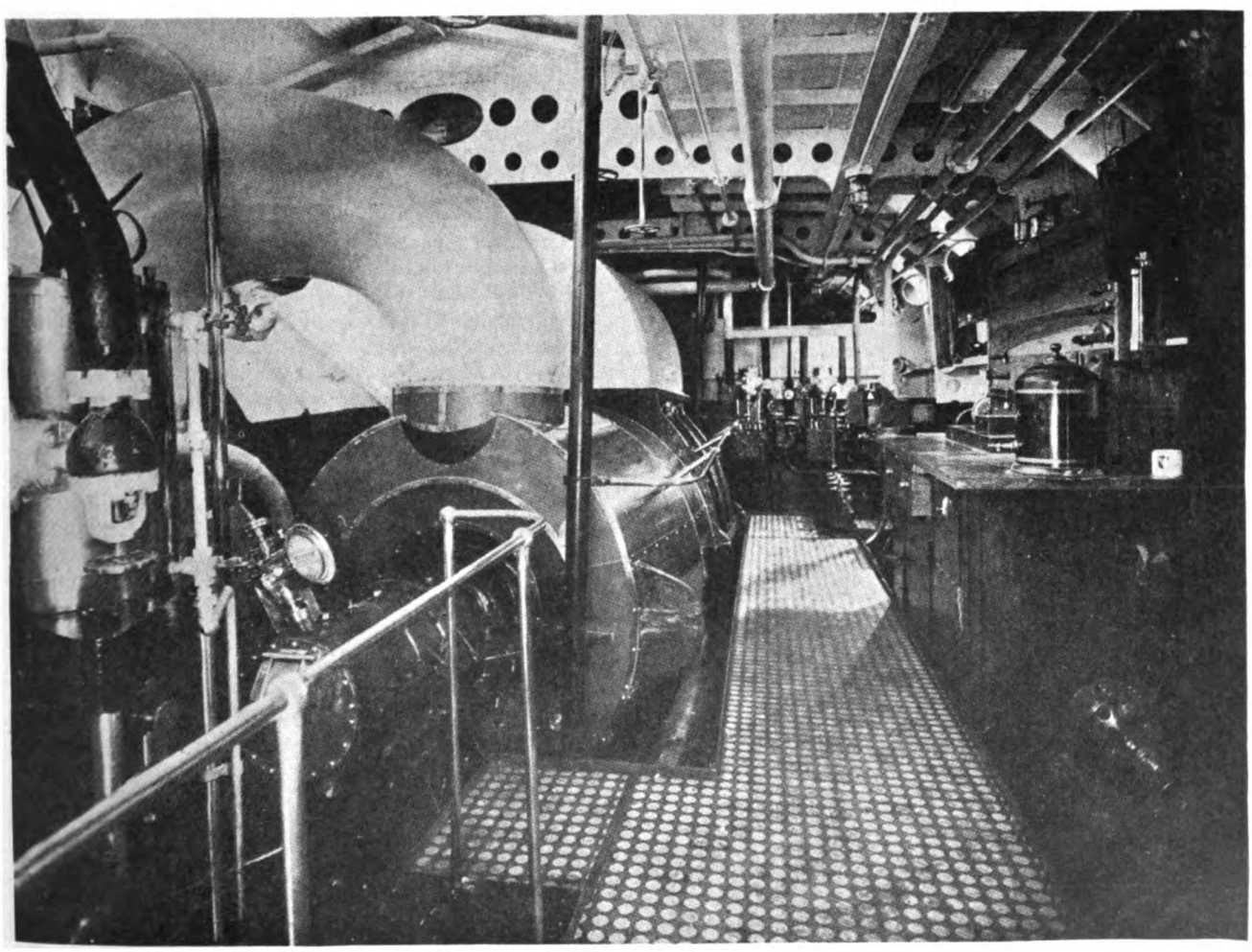

Fig. 3.—Steam Yacht *Winchester*. Interior of Engine Room

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sons turbines and designed for a speed of 29 knots at about 360 tons displacement, with the main engines developing about 7,000 shaft horsepower. The vessel was built by the Bath Iron works, of Bath, Me., from designs furnished by Cox & Stevens, of New York City.

Hull Data.—

Length overall	225 feet 0 inches.
Length, load waterline	224 feet 0 inches.
Beam extreme	21 feet 0 inches.
Beam, load waterline	20 feet 8 inches.
Draft on trial	4 feet 11¾ inches.
Displacement on trial	322 tons.

The hull is built of high-tensile galvanized steel of substantial scantling; her plating is 11 pounds amidship to 8 pounds at the ends; the shear strake, from 13½ pounds to 8 pounds, while the keel is from 12 pounds to 10 pounds. The frames are correspondingly heavy, spaced 21 inches apart. From the above it can be seen that, although high speed was desired, strength was not sacrificed. She has been given several severe tests this last summer and has yet to show a weak place. She has also proven herself to be very able, as well as comfortable, in a seaway.

As can be seen from the plans, she has plenty of accommodation for both owner and crew, in spite of the large space given up to engines and boilers.

Propelling Machinery

The boiler equipment consists of two Normand water-tube, express-type boilers with 8,184 square feet total heating surface, and each is fitted with eight oil burners of the mechanical atomizing type. The maximum pressure allowed is 260 pounds per square inch, although this pressure is never used, 31½ knots being obtained with only 225 pounds, at the high pressure turbine.

The propelling machinery consists of Parsons turbines arranged on two shafts, the high pressure turbine being on the starboard, while the low pressure with the astern turbine is on the port shaft. These were designed for 7,000 shaft horsepower at 900 revolutions per minute, and are of the following dimensions:

	H. P. Turbine, Inches	L. P. Turbine. Inches
Length of rotor	82	57 9/16
Diameter of rotor	32	42
Rows of moving blades	54	26

The thrust bearings are forward of the turbines and are of the Parsons type.

Main Condenser.—There is one main condenser of 4,163 square feet cooling surface. The construction is similar to those that have been put into destroyers built by the Bath Iron Works. The section is circular and contains 2,832 ⅝-inch tubes. The tubes are bent to a curve to allow for expansion, and the ends are rolled into the tube sheets, which are not parallel. A vacuum augmentor of the Parsons type is also provided.

Propellers.—There is one three-bladed outboard turning propeller on each shaft, of manganese bronze cast solid. The blades are true screws, machined to pitch, and polished. The following are their dimensions:

Diameter	55 inches.
Pitch	51 inches.
Projected area	1,422 square inches.
Projected area ÷ disk area	.60

Auxiliaries

The various pumps are shown in the following table:

No.	Pump.	Make and Type.	Size.
1	Main air	Warren	10″ × 22″ × 16″
1	Main feed	Warren Simplex	13″ × 9″ × 14″
1	Auxiliary feed	Warren Simplex	13″ × 9″ × 14″
1	Main circulating	Centrifugal 12″ suction and discharge engine	7″ × 5″
1	Fore and bilge	Warren Simplex	4½″ × 5½″ × 6″
2	Lubricating oil	Warren Simplex	2½″ × 4″ × 6″
2	Fuel oil	Warren Duplex	4½″ × 3″ × 12″
1	Fresh water	Centrifugal driven by electric motor	
1	Salt water	Centrifugal driven by electric motor	
1	Sanitary	Warren Simplex	3½″ × 5″ × 6″

The other auxiliaries consist of the following:

Feedwater heater of 248 square feet.

Fuel oil heater, 75 square feet.

Lubricating oil cooler, 63 square feet.

Two forced-draft blowers driven by Terry turbines.

Electric outfit consisting of a 10-kilowatt, direct-current generator driven by a Curtis turbine.

A special type of steering engine made by the Hyde Windlass Company, with two cylinders, each 4 inches by 4 inches.

A Hyde steam windlass with two cylinders, each 4 inches by 4 inches.

Trials

The trials were run in smooth water over the Government course off Rockland, Me. Twelve runs in all were made, with the following results:

Run	*Direction.*	*R.P.M. Mean*	*Estimated S.H.P.*	*Speed in Knots.*
1	N	1014.5	7020	30.38
2	S	1031.0	7360	32.11
3	N	1032.5	7580	30.98
4	S	1035.0	7485	32.09
5	N	1035.5	7360	30.90
6	S	1038.0	7470	32.32
7	N	713	3272	23.92
8	S	697	3194	24.83
9	N	497	1155	17.22
10	S	540	1320	19.87
11	N	295	269	10.21
12	S	287.5	206	11.21

After the progressive trials a two-hour run was made, on which the oil consumption was measured by sounding the fuel oil tanks. The speed obtained was 19.7 knots, and the oil consumed was 669 gallons. Taking the shaft horsepower from the curves at 1,840 and assuming a specific gravity of .88 for the oil, this would give about 1.35 pounds of fuel per shaft horsepower per hour.

In the picture shown in Fig. 2, which was taken during one of the high-speed runs, the bow wave is not very high and consists of a very thin sheet of water, as the painted water-line on the ship's sides can be plainly seen through it. The trim of the vessel at this speed is changed very little from that at rest. Had more power been supplied, no difficulty would have been experienced in obtaining very much higher speed; this is substantiated by the tank trials of the model.

A comparison of the preceding yachts bearing the name of *Winchester* with the present one is shown in the following table:

Turbine Steam Yacht "Winchester"

	Winchester No. 1	*Winchester No. 2*	*Winchester No. 3*	*Winchester No. 4*
Present name	Adroit	Flying Fox	.....	Winchester
L.W.L.	140′ 0″	165′ 0″	205′ 0″	224′ 0″
Beam	15′ 6″	16′ 0″	18′ 6″	21′ 0″
Trial draft	5′ 0″	3′ 10¾″	3′ 11½″	4′ 11¾″
Trial displacement	150 tons	136.3 tons	207.5 tons	322 tons
Machinery	Reciprocating	Parsons turbines	Parsons turbines	Parsons tur.
No. of propellers	2	3	2	2
Horsepower	About 1500 I.H.P.	About 3000 S.H.P.	About 7000 S.H.P.	8074 S.H.P.
Speed	About 20 knots	26.516 knots	32.24	31.56

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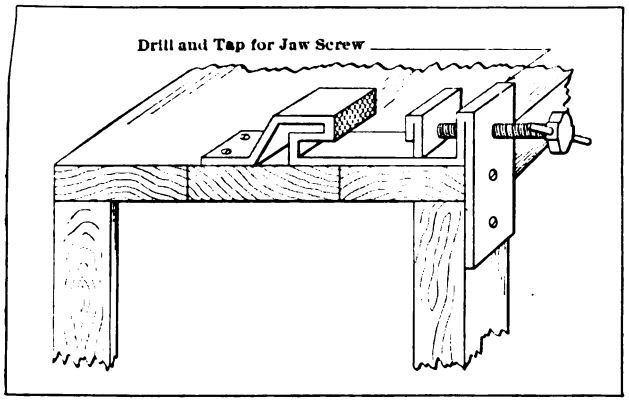
Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Bench Vise

The need of an extra vise on the bench is apparent when you have a lot of overhauling or refitting to do. There is one lying in the stock rack, or scrap pile of every ship. All you need to do is to put it together, as shown in the illustration. It can be made almost any size (mine is made



Improvised Bench Vise

out of 3-inch by ½-inch flat bar stock). It is pretty handy for filing up bearing liners, rethreading bolts and nuts, etc. It saves time waiting for the other fellow to get through using the big vise. C. H. W.

Laying Up Boilers

Perhaps a few notes on laying up boilers might be helpful to some of the readers. Too little care is generally given to this important work. I fully believe a boiler can deteriorate as fast when idle, if not laid up properly, as it will in active service. A little money spent on the boiler at the time of laying it up will save a lot of money when it is to be put back into service again.

Laying up a boiler generally means a period of from three to six months that it will not be used. It is always best to empty the boiler and wash it out thoroughly, being sure to get the mud and sediment all out. Thoroughly dry out the interior surfaces by circulating hot air from fires built close to the bottom manholes, leg handholes, or mud drums, according to your type of boiler. Remove the top manhole plate of the steam drum and place a small electric fan just inside to drive the air out. Of course a portable blower is best, if one is available.

Small pans of fire can be set in the lower or upper drums if the openings will permit. The main thing is to get the interior absolutely dry, and the next to keep it dry. After inspecting the interior and being satisfied that it is dry, set pans of unslacked lime in the upper and lower parts. Do not put any on the metal of the boiler, and be sure to use containers. This lime absorbs the moisture that might be left.

Secure all handhole or manhole plates, and all cocks and valves, making sure that the boiler is absolutely air tight. Break any feed line or other line joints that might connect with the boiler that have any pressure on them and blank them off. Make sure that all valves, try cocks and water columns are tight, and wire them shut against mischievous hands.

Clean and paint with red lead all external parts of shell, or headers, and patch the casing to prevent water leaks from rusting the outside of the shell. Make sure that no ashes or dirt are left around to hold the moisture near the boiler; if a watertube boiler, wipe all tubes outside that you can reach with graphite and thin oil; if a flue type, push a swab through. Apply this graphite wash to all external parts that cannot be red leaded.

It pays to clean thoroughly the fireside of all soot, for soot collects moisture and this means rust.

Boilers that are laid up should occasionally have a small wood fire built under them to dry the moisture that might collect. Take some steps to prevent rain coming down the stack or uptake, to which idle boilers are connected.

Boilers that are to be idle for but a few weeks should be kept full of fresh water of about one-half percent alkaline strength, and under a pressure of about 25 pounds, making sure to expel all air. Do not forget to slush the safety valve parts with oil or vaseline. W.

"Safety First" Kink

The floor plates at the foot of the engine room ladders on board ship were of the straight-rib design, as shown in Fig. 2. The ribs ran in the same direction as the traffic that passed over them. Constant wear had worn these smooth; this, combined with the oil and grease (which is ever present in all engine rooms, even after they are wiped

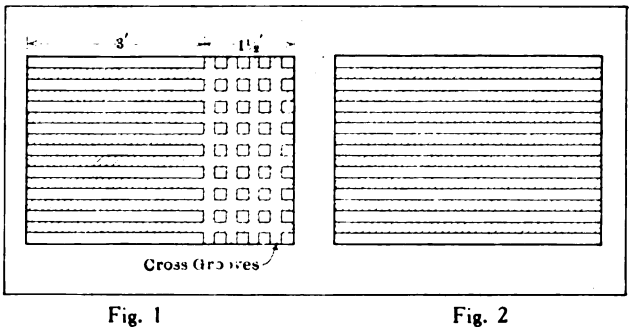


Fig. 1 Fig. 2

down), makes them slippery and dangerous, especially during rough weather. To cure this trouble, at the base of the ladders I cut cross grooves in the plates for about 1½ feet of the plate, as shown in Fig. 1, using an air hammer and round gouge chisel.

I like the result so well that I shall change the floor plate near the engine throttles in the same manner. There are plates of this pattern on the market, but I have never seen any used on board ship for floor plating. I think perhaps the reason is that it is harder to keep this pattern of plate clean when the grooves run both ways of the plate, but the tread is much safer. GRATING.

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Kink for Making Bearing Liners

Recently when overhauling some machinery that included relining some bearings with babbitt metal I was at loss for some liner material to take up the distance between the bearing cap and bottom brass.

The required liner needed to be about 3/16 inch thickness. This was too much space to fill full of thin liners, and not having any brass sheet of this thickness or other suitable material on hand I hit upon the following idea:

Some short pieces of ½-inch and 1½-inch brass pipe were lying in the scrap pile. This I took and split lengthwise, and after annealing flattened this out, and a little dressing with a file gave me plenty of liner material. Various size pipe will give the different thicknesses required for most any large bearing.

This kink is handy on shipboard, where sometimes the scrap pile in the old storeroom is a labor saver.

CHIEF.

Valve Troubles and Some Cures

There probably is not a steam power plant engineer in existence that has not been confronted with the frozen valve stem trouble. We've all had more than one or two of these disagreeable out-of-the-way valves that were opened and shut only once in a while, and finally, just when they were needed to cut a section of the line, or to by-pass something, they would not budge, even with a good-sized monkey wrench used as a leverage on the hand wheel. This generally twisted the stem off or twisted it so badly that a new one had to be made in the shop.

My plan when I find a valve with the stem frozen in the yoke, or one that works so stiff that the use of a wrench to move it is required, is to take a gasoline torch, heat the yoke around the stem, tap good blows with a suitable hand hammer and keep persuading the stem to move back and forth, using fine strips of emery cloth to clean the threads close to the yoke, blowing the dirt away before entering the cleaning part into the yoke. Patience is required for this work, especially if the valve is located in an uncomfortable place.

When the stem fails to move after trying the heating as above mentioned, there is but one other method that I know of to try. This is to take the valve bonnet off and to remove the disk; then tap the ends of the valve stem in addition to the yoke. Secure the bonnet in a vise, or, if the valve is too large, clamp it to some angle plate. A pipe wrench can be used on the part of the stem next to where the disk was secured, and the hand wheel and another wrench can be used on that part of the stem above the yoke. This method gives the power to move, yet divides the twisting strain between both ends of the stem. This, of course, can only be done if you are able to take the valve apart, having no pressure to deal with.

After getting the troublesome stem out and cleaning the threads of the stem and yoke, if you cut a slot similar to a keyway down through the threads on one side of the stem, this will always clean the threads out each time the valve is used and it does not weaken the stem enough to do any harm. I have tried this on more than twenty different size valves and it works splendidly.

Many times a steam valve is closed so tightly that it seems like the stem is frozen, when really all that is wrong is that the valve has been jammed shut and the line temperature changed so that it has contracted the parts of the valve, and thus set the valve disk tighter on the seat. When a valve is found in this condition the yoke through which the stem works can be slacked away enough to ease the strain and then the stem can be moved.

When the valve is one in which the yoke cannot be slacked away from the bonnet or bonnet studs on account of its design, the best thing to do is to slack the bonnet away at the flange. Of course this means that the pressure on the valve must be taken off first.

These methods will save considerable damage to the valves if you have a little patience. C. H. W.

Feed Water

There are many little installations of pipes and fittings for saving the drains and drips of fresh water about the plant on board this ship that I think have well paid for their cost of installation, and perhaps some other engineer might be able to save a few dollars on feed water by following the same plans, where possible, on board his ship.

Our feed or filter tanks are of 3,500 gallons capacity, one in the starboard and one in the port engine room. The discharge of all auxiliary and main air pumps is led into the top of these tanks; also two drain lines, one from the discharge of the various steam traps, and the drain line from the cylinders of the auxiliary machinery. These drains all enter the tanks at about 4 feet from the bottom and are led well into the tank by internal distributing pipes. This effectively heats the water to about 180 to 190 degrees. The main feed pumps can be supplied with water either direct from these tanks or by the hot well or lift pumps. The lift pump is always used, for its suction is below the bottom of the feed tank and it takes water of 190 degrees and delivers it through a feed heater to the suction of the main feed pumps at 230 to 240 degrees.

Our make-up or extra feed water is carried in reserve double bottom compartments. These compartments are connected to the suction of the lift pumps. Between this suction line to the bottoms and the suction to both main air pumps we have installed a two-inch pipe line with a globe valve next to the air pump end. This line is used when the ship is underweigh to keep the supply of feed water in the feed tanks at about 3,000 gallons. By regulating the opening of the globe valve next to the air pump it will by means of the air pump vacuum draw from any bottom a slow, steady supply of extra feed and deliver it to the feed tanks without knocking down the temperature of the feed water or destroying the vacuum.

We have installed a 2-inch drain line pipe from the bottom of each safety valve escape pipe, leading these to the nearest reserve bottom filling line. These save an untold amount of water when the valves are blowing. Also the atmospheric exhaust and the vapor pipes from the hot well are connected to one of these escapes so that this increases the saving.

The drains of all auxiliary machinery are led to the hot wells in a separate line. At the throttle valve of each pump and piece of machinery on the steam line side of the valve the body is drilled and tapped for ¼-inch pipe, and this fitted with a globe valve and ¼-inch piping to drain the accumulated water into the drain line before starting, saving a great deal of water being forced through the machinery and out through the rod packings. It also affords a means of draining the steam line to the pump or machinery when the root valve is closed at the main steam line. It is a rule in this plant that when a piece of machinery is put out of use its root valves be closed in addition to valves on the piece of machinery.

The discharge of all relief valves of feed pumps is led either into the suction chambers of the pumps or to the feed tanks, and, if possible, and too much piping is not required, they are led when possible to the nearest reserve

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bottom. The reason that I speak of this is that when the relief valves discharge into the suction chambers there is generally some trouble experienced with the pump losing its suction. This is due to the water in the suction chamber being forced out by the air that collects in the short section of pipe connecting the relief valve to the suction chamber. This makes the pump air bound. It is also thought that the water being discharged at a high pressure and velocity helps to cause these troubles.

Often it becomes necessary (when some pump or steam line is disabled) to shift the water from one boiler to another or one tank to another, etc. If air compressors are on board this can be easily accomplished by placing an air pressure on the boiler or tank, say about 50 or 60 pounds. This will displace the water to most any place desired. Portable steam siphons are very handy for drying out double bottoms below the pump suctions, saving a lot of bailing of water when it becomes necessary to dry the bottoms for painting.

Recently on a trip of some 6,000 miles we had one of the tube sheets of the starboard main condenser spring a leak, and as it was pretty bad weather the skipper ordered the chief to continue steaming until we had better weather before he would let us stop the starboard engine. This leaking of salt water continued for two days, and the result was that the eight boilers and both feed tanks were run up to about 500 to 600 grains of salt per gallon. (This was some 30,000 gallons of water.) The boilers were of the Babcock & Wilcox watertube type, so it was urgently necessary that further steaming with high saturation be stopped as soon as possible.

Just as soon as we were able to stop the starboard engine the chief decided to save the water, so fires were lighted in four new boilers, and the fires allowed to die out in four of the salted ones. The speed was reduced to 5 knots with one engine, and the water of the starboard feed tank emptied into an empty reserve bottom, then refilled with fresh water. As soon as the four new boilers were cut in they were fed from the fresh water in the starboard tank and the remaining four salted boilers cut out. The water of the port feed tank was then emptied in the same bottom as the starboard tank and refilled with fresh water. This gave us four new boilers steaming and feeding with fresh water.

Four of the salted boilers were next run into a reserve bottom and refilled with fresh water, and as the work on the condenser was nearly finished they were started, and soon we were again at standard speed.

We then looked at the evaporator log and selected the cleanest evaporator and re-evaporated the 30,000 gallons of salted water, first taking that from the bottoms that we had filled and next that in the remaining four salted boilers. The water was supplied to the evaporator feed pump by pumping it up there through a few lengths of fire hose, as there was no regular run of piping that we could use.

The chief figured that he saved some coal in doing this stunt, for it was forced through the evaporator at a high rate of evaporation and it did not leave as much salt scale on the coils of the evaporator as the evaporating of that much sea water would have, therefore not using as much steam.

ECONOMY.

NORWEGIAN SHIPPING LOSSES.—The total war losses in the Norwegian merchant marine up to November 30, 1916, according to recent Consular reports, have been 242 vessels of 325,415 gross tons. Of these vessels 182 were steamships of 281,628 gross tons.

Delivery from Centrifugal Pumps

In the November issue an article of mine dealing with feed pump valves drew attention to the fact that centrifugal pumps were usually designed upon a velocity basis of 10 feet per second.

The exact velocity basis of any centrifugal whose revolutions are known can be easily obtained during overhaul. All that is needed is a tape measurement round the circumference of the impeller in feet and decimals. Multiply this length by the revolutions per minute and dividing by 60 gives the velocity in feet per second.

$$\frac{\text{Circumference in feet} \times \text{revolutions per minute}}{60} = \text{velocity,}$$

feet per second.

In a case where the revolutions are unknown these may be obtained by the converse method of assuming 10 feet per second as velocity. The 10 feet multiplied by 60 to give a minute and divided by circumference of impeller in feet gives the revolutions necessary.

As a formula:

$$\frac{60 \times \text{velocity in feet per second}}{\text{Circumference in feet}} = \text{revolutions per minute.}$$

As examples a 15¼-inch diameter impeller with a circumference of 48 inches should run at 150 revolutions per minute, while a 7⅝-inch diameter impeller needs double the revolutions (300) per minute.

It is necessary in the case of centrifugal pumps to rid the mind of the question of displacement, and for this reason the centrifugal presents a little difficulty in comprehension to many practical men. In a high-lift centrifugal in stages, for example, the step up is not in pressure, but in velocity. Hydraulic engineers have no such difficulty, as even in a reciprocating pump the term head (expressed in feet) is more usual than that of pressure.

Velocity and pressure are interchangeable terms in the vocabulary of the hydraulic expert, and the boiler-feed injector and the centrifugal pump have a basis in common —velocity—although imparted quite differently.

To understand the steam turbine it is necessary to get rid of the pressure-displacement idea altogether. If you imagine a man jumping onto a wheeled truck and by so doing his momentum moves the truck, it is an analogy practically perfect. Multiply the one man by thousands in quick and regular succession and it is obvious that the truck would have considerable velocity imparted. Now, this illustration is true for the injector; the centrifugal pump and the turbine, whether water or steam is the fluid dealt with.

The two main factors in hydraulic practice are velocity and friction—the first imparted by mechanical means, the second a loss whose amount is increased by faulty design. That velocity can be increased independent of further power is realized when the shape of the fire hydrant branch pipe is observed. By constriction of the outlet in a suitable manner the height of the jet thrown can be increased. The two factors here are the exact shape of the outlet and the constriction, which increases the velocity but diminishes the pressure just before the point of exit.

In a stage centrifugal the results are obtained with equal-sized impellers by the transference of velocity to pressure between each stage. The water is momentarily brought to rest between each stage and the velocity imparted by the succeeding impellers is given to water already under pressure, much in the same way that pressure in town mains is not lost when passed through a pump to give increased pressure.

As already stated, the outlet of a centrifugal pump can

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be closed with impunity, and under these conditions less power is required.

The defects of a centrifugal are, first, that it is most economical under the conditions of designed head and speed. A reciprocating pump absorbs power proportional to varying head and speed, but while the power used with a centrifugal varies with the work done, its efficiency is badly impaired by alteration from its designed duty. The second defect is that it has no natural suction and must be primed to start. This makes the provision of a first class foot valve indispensable. Again, it is not unusual for a centrifugal to absorb more power, lifting as it does a much larger quantity with the lowest head. While at a constant speed the volume delivered varies greatly by alteration in head with a velocity pump, with a reciprocating pump under the same conditions the quantity remains constant under any head or pressure. The plunger or piston pump locks off successive determined quantities of fluid, the centrifugal varies its volume inversely as the head.

It is therefore important that the speed and head for which the centrifugal is designed be held constant, hence perhaps the value of a realization of the velocity basis upon which most centrifugals are based.

Under certain circumstances, no data being available, it, may prove useful to have a simple rule to estimate the quantity likely to be obtained from a velocity pump. If the diameter of the discharge pipe be measured and its area in square inches determined, this area multiplied by the constant 26 will give the gallons per minute Imperial. The area in square inches multiplied by the constant 31 will give the output in United States gallons. The relation between the two standards is variously expressed as 10 : 8⅓, 100 : 82, 30 : 25, or exactly 277.463 : 231.

As a formula:

$A \times 26 =$ 1 gallon per minute.
$A \times 31 =$ United States gallons per minute.
$A =$ area, always in square inches.

The errors in the results so obtained are very trifling. Imperial minus .2 percent, United States plus .38 percent, the exact results being 25.95 and 31.12, respectively.

The errors so introduced are not greater than that due to error in workmanship in the pump itself or in observation as to speed. The difference between 259 and 260 revolutions is greater than the error in the formula given. Timing revolutions with a stop-watch and speedometer is certainly less accurate than the results of the formulæ.

For any other velocity it is necessary to multiply by the factor introduced. For example, velocity is found to be 9.6 feet per second by measurement of impeller and revolutions. The area of a 12-inch discharge pipe is 113 square inches; multiplied by 31 this equals 3,503 U. S. gallons. If this result be now multiplied by .96, the correction for the lower velocity is easily made.

It is hoped that the constants given above may prove useful, while the attempt to elucidate some of the main features of the centrifugal pump may prove helpful to a minority, at all events, of readers.

London. A. L. HAAS.

ANNUAL MOTOR BOAT SHOW.—The Thirteenth Annual Motor Boat Show was opened in the Grand Central Palace, New York City, on Saturday, January 27. It will remain there until the following Saturday evening, and during that time yachting enthusiasts from all parts of the country will make their headquarters in the Grand Central Palace. During the week meetings will be held of associations organized for the benefit of the sport, and of the National Association of Engine and Boat Manufacturers, under whose auspices the show is held each year. Every inch of floor space has been taken and many large yachts are to be exhibited.

This year the show takes on a naval aspect. The decorations are blue and gold, the navy colors, and these decorations are very artistic. Because of the preparedness movement yachtsmen have of late been building boats that can be used as patrol or scout cruisers. The motor boat has proved its worth in the present war, and owners of boats are ready to help in case of hostilities with their craft, and they go further by building boats to conform to the types suggested by the Navy Department.

Two boats, 45 and 66 feet long, have been built to show what type is needed, and models of these boats have been made by the Boucher Manufacturing Company, which show them fully equipped.

Mono Marine CO_2 Recorder

(*Concluded from page 67.*)

the volume of the gas is ascertained. Pipe 5 is in communication with the outside air and the upper part of pipe 6 passes into an expansion of pipe 8, Fig. 3.

The lower part of pipe 6 passes into the bottom of a recipient, 2, and is thus only indirectly in connection with the mercury in flask 3. The position of this inner recipient, 2, in flask 3 is such that the mercury in pipe 6 will always rise higher than that in pipe 5 or 8, Fig. 3.

As the pressure is increased the mercury is finally forced out of the recipient 2 through pipe 6 and runs down into pipe 8, Fig. 3. As soon as pipe 6 is empty of mercury the pressure medium comes in contact with the outside air and the excess pressure in flask 3 disappears. The mercury in pipe 4 and 5 then runs back into flask 3, filling it until some of it finally runs into the recipient 2. By this means the lower outlet of pipe 6 is closed. The pressure medium is now no longer in contact with the outside air and the pressure rises again in flask 3, and the process above described is repeated. In this way an alternately rising and falling movement of the mercury is brought about, which movement is utilized in the following manner:

When the mercury sinks, as above described, the gas to be analyzed is drawn in from the funnel through the filter and the tubing to the absorption apparatus. Through the coupling, 9, the mercury seal, 10, and the pipe, 11, this gas then passes into the burette, 7, where it is measured, the pressure and temperature always being constant. When the mercury rises, the gas from the burette is compressed through pipe 13, the mercury seal 14 and pipe 15 into the recipient 16, which is filled with absorption liquid. The carbonic and sulphuric acid in the gas is here absorbed, the remainder of the gas being compressd through pipe 18 up in the gasometer 20, which is shut off from the outside air by water.

When the gas enters, the gasometer rises and turns the wheel 21, which in its turn finally acts on the wheel 22. On this wheel and connected with it by means of a metal pin hangs the pen 23, which draws the curve on the diagram paper 24. The lower extremity of the line produced indicates the percentage of gas absorbed.

When gas is drawn into the burette, pipe 17 comes in contact with the outside air, the gasometer then sinks back to its original position and the apparatus makes a new analysis and a new registration.

The method of suspending the instrument is clearly shown in Fig. 6. To the left, slightly above the instrument, will be found the Mono monoxide auxiliary which makes the analysis of CO possible. The marine type Mono apparatus is driven either by water or compressed air, whichever is more suitable to local conditions.

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT*

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, and defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Formula for Critical Speed of De Laval Turbine

Q.—Will you please quote me a formula, if there is one, which will permit me to figure the critical speed of the shaft of a de-Laval turbine? S. D.

A.—Considering the bearing as supported, not fixed, in bearings equally spaced from the rotor, the following, given by Loewenstein, may be used:

$$R.\ P.\ M.\ \text{for critical speed} = 1{,}550{,}000\ \frac{d^2}{l \vee W l}$$

where d = diameter in inches; W = load applied; l = distance from c. to c.

Size of Safety Valve for Air Compressor

Q.—Please calculate the size of the safety valve necessary for a two-stage air compressor delivering 130 cubic feet per minute at 110 pounds per square inch gage? C. A. P.

A.—Assume that the discharge temperature from the high pressure is 60 degrees F.

Using Reynolds'† formula for air to determine the effective area of the valve.

$$Q_1 = \frac{405\,A\,(P_1^2 - P_2^2)^{0.48}}{\sqrt{T}}$$

Q_1 = quantity of air discharged in cubic feet per minute at 32 degrees F. and 14.7 pounds per square inch absolute,
A = effective area, square inches,
P_1 = delivery pressure from high-pressure stage, pounds per square inch absolute,
P_2 = atmospheric pressure, pounds per square inch absolute,
T = absolute temperature of air from high-pressure stage.

$$\frac{P_1 Q_1}{T_1} = \frac{P_2 Q_2}{T_2}$$

$$\frac{144 \times 14.7 \times Q_1}{32 + 460} = \frac{144 \times 124.7 \times 130}{60 + 460}$$

Q_1 = 1043. cubic feet.

$$\text{Then } 1043. = \frac{405\,A\,(124.7^2 - 14.7^2)^{0.48}}{\sqrt{60 + 460}}$$

A = .575 square inch.
Assume lift = .06 inch.

$$\text{Circumference} = \frac{.575}{.06} = 9.58 \text{ inches.}$$

Diameter = 3.05 inches.

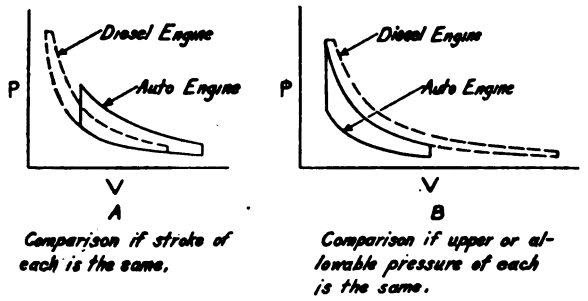
*Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.
†"The Flow of Air and Steam Through Orifices." H. B. Reynolds, Journal of the American Society of Mechanical Engineers, 1917.

Constant Volume vs Constant Pressure Cycles

Q.—In view of the fact that the Diesel engine has proved so efficient and popular for marine practice, why has not it been developed for automobiles ashore? D. E.

A.—The Diesel engine is necessarily a much heavier unit in pounds per brake horsepower than the present type of automobile internal combustion engine, which works on the so-called "constant volume" cycle. The two cycles are given below and it is obvious that to do the same work for a given cylinder diameter and length of stroke the Diesel diagram must have the same area and therefore much higher pressure, or if we permit both cycles to have the same maximum pressure the Diesel must be much longer for the same cylinder diameter to produce the same power, and therefore will require a longer stroke and heavier engine.

The "constant volume" cycle receives its heat at constant volume by the ignition of the charge after compression and when the piston is practically stationary at the



Comparison of the theoretical cycles of the automobile (constant volume cycle) and Diesel (constant pressure cycle) engines. As drawn all produce the same work per stroke for the same diameter cylinder.

end of its stroke. The Diesel "constant pressure" cycle receives its heat by the injection of fuel during the early part of its working stroke and at such a rate that if cut off the pressure remains constant.

This comparison is of fundamental cycles, and in addition to the disadvantage here shown is the auxiliary apparatus necessary for the Diesel unit.

Coal Bunker Measurement

Q.—How many cubic feet are allowed per ton in estimating the capacity of coal bunkers? C. B. M.

A.—Usually 44 cubic feet of bituminous coal, unless coal of a known character is to be used continuously, in which case the actual value of that coal should be used. With different types of coal it varies from 36 to 50. Mackrow* recommends for British Practice 40, derived from the Admiralty allowance (1 ton = 2,240 pounds).

Setting Valves to Triple Expansion Engine to Get Least Vibration

Q.—Please print in next month's copy of MARINE ENGINEERING the best way of setting valves on a triple-expansion marine engine to get least vibration, sequence of cranks, H. P., M. P. and L. P. R. E. C.

A.—The setting of the valves of any engine has no effect directly upon vibration, and as a premise to the act-

*The Naval Architects' Shipbuilders' and Engineers' Pocketbook by Mackrow and Woollard. The Norman W. Henley Publishing company, New York.

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ual answer to your question, just a word about vibration. Vibration is due to the inertia effects of the reciprocating parts and unbalanced rotating members, and is not affected by the *steam forces* in the cylinder in any way.

Valve setting affects the *work done* in the cylinders and changes in setting only cause corresponding changes in the proportional part of the total work which is done in each end of each cylinder. If, however, there is a serious inequality in the work performed by each element it may result in gross irregularity of turning moment, therefore lack of uniformity of angular velocity and irregular motion of reciprocating parts. This would affect vibration, but very rarely is the irregularity so great, especially with multiple cylinder engines, and if sufficient appreciably to affect regularity of turning it would be very noticeable in the indicator diagrams.

It is desirable, however, that each end of each cylinder do an equal fraction of the total work and "balancing" an engine by the valve setting commonly means the attempt to obtain this equal distribution of work. In practice the problem is usually presented in one of the two following forms: (a) with full information from the drafting room as to the proper location of events and position of valve; or, (b) no information other than possibly indicator diagrams.

Case (a) is the simplest, and only involves a thorough realization that usually but two quantities are adjustable, length of valve rod and location of eccentric; and further that the effect of changes in the former is to vary the distribution of work between the head and crank ends of a cylinder and the effect of changes in the latter is to vary the timing of the events, but affecting both ends in the same way.

For example, if the valve is a "direct" valve (taking steam on the outside and and no rocker), shortening the valve stem will increase the work done in the head end, but decrease the work done in the crank end, while decreasing the angular advance will delay cut-off and all events for the head end and will also delay all events for the crank end.

The usual procedure is first to adjust valve stem lengths to give approximate regulation of events; then to get the final adjustment by varying the eccentric. For case (a) a common procedure is to work for the designed lead. Each cylinder is set separately and the valve adjusted so as to get as nearly as possible the designed lead on the top center; then the engine is rolled over onto the other center and the lead measured. If not nearly that on the top center, the valve is raised or lowered one-half the difference. The same treatment is given to each cylinder successively and the accuracy of the setting for the entire engine depends on the accuracy of the data given the shop by the designer and the accuracy of the shop in keying the eccentrics.

Some shops set by the designed steam lap instead of the lead, as the quantity measured is greater and the error of measuring from the rough edge of the port is less. On piston valves the measure of the setting is observed through the peek holes provided for that purpose and on flat valves the valve chest cover is removed.

Case (b) is more involved and the procedure to follow depends largely upon the information available. In general, however, it is well first to adjust throughout for equal leads by the valve stems alone; then adjust eccentrics to even up approximately the events of both ends. If the eccentric is changed through a large angle, it is desirable again to adjust on lengths of valve stems for equal lead, and then follow up by a further adjustment of the eccentric. The engine should then be put under steam, indicator diagrams taken and the equalization of work per cylinder made from the information which they in this way furnish.

The following table will be helpful in noting the effect of various changes in valve setting for a three-cylinder, triple-expansion engine:

GENERAL EFFECT OF CHANGES IN VALVE SETTING
(Valve Direct Connected taking Steam on Outside)

Member Changed	Change	Admission	Cut-off	Release	Compr'ss	Max. Port opening, Steam.
Eccentric	Ang. Ad. Inc.	Earlier	Earlier	Earlier	Earlier	No effect
"	" " Dec.	Later	Later	Later	Later	" "
Valve Rod	Length. H.E.	Later	Earlier	Earlier	Later	Decrease
	C.E.	Earlier	Later	Later	Earlier	Increase
" "	Short. H.E.	Earlier	Later	Later	Earlier	Increase
	C.E.	Later	Earlier	Earlier	Later	Decrease
Steam lap	Lengthen	Later	Earlier			Decrease
	Shorten	Earlier	Later			Increase
Ex. Lap	Lengthen			Later	Earlier	Decrease
	Shorten			Earlier	Later	Increase

EFFECT OF CHANGING CUT-OFF
Three-cylinder, Triple Expansion Engine.

Member changed	Effect on Work Done in		
	High	Int.	Low
Lengthened in H. P.	More	More	About same
Shortened in H. P.	Less	Less	" "
Lengthened in I. P.	More	Less	No change
Shortened in I. P.	Less	More	" "
Lengthened in L. P.	Same	More	Less
Shortened in L. P.	"	Less	More

BOOK REVIEW

PRACTICAL SHIPBUILDING. Third edition. By A. Campbell Holms. Volume I (text); size, 6 by 9¾ inches; pages, 637. Volume II (diagrams and illustrations); size, 15½ by 12½ inches. Plates, 115. New York and London, 1916: Longmans, Green & Company. Price, $17.50.

The first edition of this standard work on shipbuilding was published in 1904, and a second edition, thoroughly revised, was published in 1908. Since the publication of the second edition further changes and developments have occurred in shipbuilding and departures from current practice, formerly exceptional or tentative, have now become general, and in various ways the structural design of vessels has been modified, principally with a view to securing increase of efficiency by reduction in weight and cost of construction. For this reason a third edition of the book has just been published.

In the third edition the revision has been extensive and thorough. Large portions have been entirely rewritten and the whole has been brought up to date by numerous additions, alterations and amendments. Three new chapters have been added on longitudinal framing, damage repairs and lifeboats and davits. A large amount of new matter has also been added in connection with oil vessels, oil fuel, fire extinguishing, freeboard regulations and bulkhead subdivision. Eighteen new plates have been added, several have been redrawn or suppressed in favor of others more instructive, and many have been amended so as to bring them up to date. The index has been carefully revised and amplified. As in previous editions the rules of Lloyd's Register are more particularly referred to, due probably to the fact that the author is a surveyor of Lloyd's Register of Shipping, but more space has been devoted, nevertheless, to the rules and methods advocated by other classification societies, the numerous references to which will be found both instructive and interesting.

The book, as a whole, represents the most complete work in existence on the subject of practical shipbuilding. The illustrations, reproduced to a large scale, are authentic and the whole work is a reliable guide to modern practice in steel ship construction.

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Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

Steel merchant vessels building, or under contract to be built in private American shipyards on January 1, according to builders' returns to the Bureau of Navigation, Department of Commerce, numbered 403, of 1,495,601 gross tons, the largest tonnage in the history of American shipbuilding.

During December, 1916, American yards completed nine steel merchant vessels of 24,363 gross tons and entered into new contracts for twenty-nine vessels of 105,120 gross tons.

Barring unforeseen delays American shipbuilders expect to launch during the current calendar year 357 vessels of 1,250,722 gross tons.

Shipbuilding Contracts

Johnsen & Kildal, Inc., ship brokers, 26 Cortlandt street, New York, are in the market to contract for the building of two vessels of 8,800 tons each of the *Niels Nielson* type; four vessels of the improved *Frederickstad* type, and about six auxiliary motor schooners. This firm is also in a position to place any kind of vessel for ocean traffic for the account of several Norwegian buyers who desire to enlarge their present fleet of merchant vessels.

The Winslow Marine Railway & Shipbuilding Company, Winslow, Wash., has under construction a two-masted wooden steam schooner of approximately 1,250,000 gross tons for the Coastwise Steamship & Barge Company, Seattle, Wash. The propelling machinery will consist of a triple expansion engine of approximately 900 indicated horsepower, supplied with steam by two Heine watertube boilers, manufactured by the Union Iron Works Company, San Francisco, Cal. The engines are being built by the Seattle Construction & Dry Dock Company, Seattle, Wash.

The Washington Overseas Shipbuilding & Construction Company, Seattle, Wash., has received a contract from J. W. Isherwood, New York, for four auxiliary five-masted wooden schooners to cost approximately $230,000 etch.

The Superior Shipbuilding Company, Superior, Wis., has received an order from Norwegian parties to build four ocean-going freight ships. Each ship will be 261 feet long.

The Wallace Shipyards, Vancouver, B. C., have the following vessels under construction: One 4,500-ton steel freight ship for Japanese owners; one 4,500-ton steel freight ship for Norwegian owners; four 8,800-ton freight steamships for Norwegian owners; six 2,500-ton auxiliary schooners for The Canadian West Coast Navigation Company, Vancouver, B. C.

Phillip H. Doyen, South Portland, Me., states that he has contracts to build about one million dollars' worth of ships for Greek owners.

The Western Dry Dock & Shipbuilding Company, Fort William, Ont., has closed a contract for the construction of six ocean-going steamers and two freight ships for service in the Great Lakes. It is announced that the capacity of the company's plant is to be doubled.

The Pacific American Fisheries, Bellingham, Wash., is planning the construction of two more ocean-going ships.

The Electric Boat Company, Bayonne, N. J., has received an order to build some more 80-foot high-speed power boats for the British Government.

The Greenport Basin & Construction Company, Greenport, L. I., will build sixteen more high-speed power boats for the Russian Government.

The American Bridge Company, Pittsburg, Pa., has received a contract from the United States Steel Corporation, New York, to build seventy steel barges.

The C. Hildebrandt Dry Dock Company, South Rondout, N. Y., will build four large wooden barges for the Darrow-Mann Company, Boston, Mass.

The McLain Contracting Company, Baltimore, Md., will build a 95-foot wooden power lighter for the Costa Rica lumber trade. The lighter was designed by Bowes & Mower, Philadelphia, Pa.

No bids of a satisfactory nature were received by the Navy Department, Washington, D. C., for the construction of two colliers of 12,000 tons capacity. It is probable that specifications will have to be re-advertised.

Contracts are pending for about twenty-five steamers for 1918 delivery, and it is probable that orders will be placed for all of them during the first quarter of 1917, if shipyards can see their way clear to cover steel requirements.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has received a contract from the Vacuum Oil Company, New York, to build two large tank steamships. The Harlan & Hollingsworth Corporation has also received a contract from the Vacuum Oil Company to build a general cargo steamer.

The Union Iron Works Company, San Francisco, Cal., has a contract to build a large oil tank steamer for the Vacuum Oil Company.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Luckenbach Steamship Company, New York, to build two more 10,000-ton freight steamships. This makes a total of five steamers which the Fore River Shipbuilding Corporation is now building for the Luckenbach Steamship Company.

The Maryland Steel Company, Sparrows Point, Md., has received a contract from the Spanish-American Iron Company, Philadelphia, Pa., to build two freight steamships.

The Fore River Shipbuilding Corporation, Quincy, Mass., has received a contract from the Government of the Argentine Republic to build a fuel steamship, 330 feet long, to cost about $600,000.

The American Shipbuilding Company, Cleveland, Ohio, has received a contract from the Pittsburgh Steamship Company, Cleveland, to build another 600-foot ore boat, making three of that size ordered for 1917 delivery.

It is reported that the American Shipbuilding Company has received a contract from Carl D. Bradley, president of the Limestone Transportation Company, Rogers City, Mich., for a $500,000 ship for 1917 delivery.

The United Engineering Works, San Francisco, Cal., has received a contract from C. Henry Smith, Inc., San Francisco, Cal., to build a 340-foot steel freight steamship.

The Navy Department, Washington, D. C., has awarded a contract to the New York Navy Yard to build battleship No. 43 at a cost of $7,690,925.

The Navy Department has awarded the Mare Island (Cal.) Navy Yard the contract to build battleship No. 44 at a cost of $7,413,156.

Johnson Bros. & Blanchard, Seattle, Wash., have a contract from the Westwood Navigation Company, Seattle, to build a 150-foot wooden vessel to be equipped with twin-screw gas engines.

It is reported that the Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., has received contracts from Norway to build four more oil engined ships.

It is reported that The Texas Company, New York, has purchased the shipbuilding plant of Arthur Sewell at Bath, Me., and will shortly begin the construction of a fleet of 20 steel barges for transporting oil in bulk.

It is reported that the Government of Canada is planning to authorize an issue of bonds to provide for the building of 30 four-masted ships to be turned over to lumber manufacturers of British Columbia. It is said that enough bonds have already been subscribed to make it possible to lay the keels of six of these ships within a few months.

It is reported that the Atlantic, Gulf & West Indies Steamship Lines, New York, have decided to build several large passenger ships.

The Electric Boat Company, New York, has signed a contract with the Navy Department, Washington, D. C., to build twenty-one submarines, of which twenty will be of the coast defense type and one of the fleet type. The contract involves about $17.000,000.

Babare Bros., Tacoma, Wash., have received a contract to build thirty-five fishing boats and cannery tenders, at an aggregate cost of about $230,000.

George F. Thorndyke, a ship broker of Seattle, Wash., has asked for tenders for six wooden four-masted schooners of the Pacific Coast type, each to be of 1,000 tons net register.

The Richard T. Green Company, Chelsea, Mass., has received a contract to build a four-masted wooden barkentine for the Federal Transportation Company.

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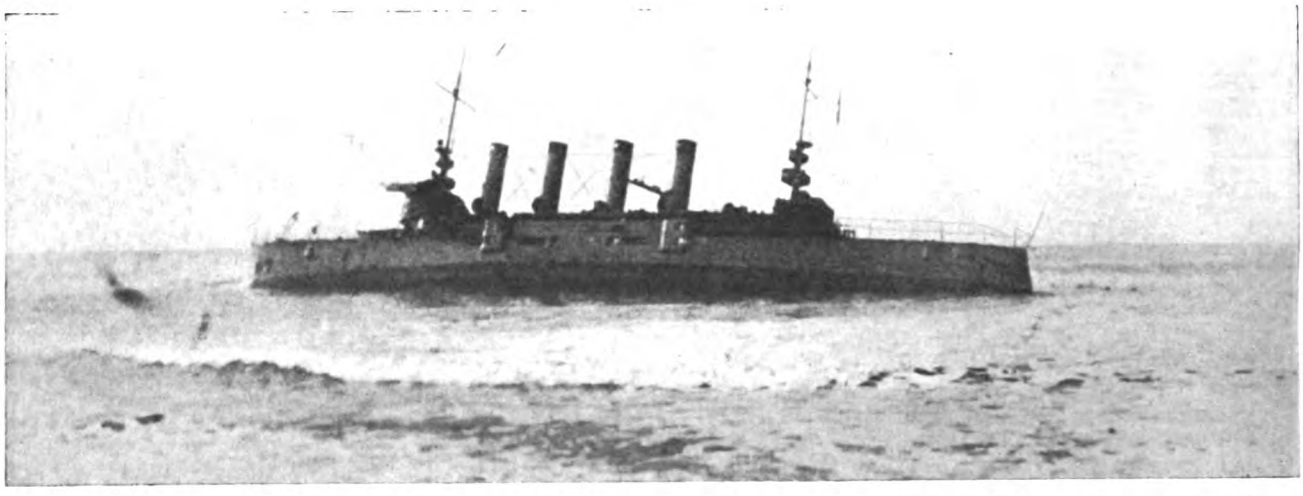


(Photograph by Press Illustrated Service, Inc., N. Y.)

U. S. Cruiser *Milwaukee* Becomes Total Loss When Driven Ashore on Shoals off Eureka, Cal., on January 13

Shipbuilding Notes

The Standard Shipbuilding Company, New York, has let a contract for the steel to be used in the enlargement of its plant in Shooter's Island.

It is stated that the People's Shipbuilding & Construction Company has been organized, and that a yard for building wooden vessels will be erected at Gig Harbor, Wash.

F. O. Northrup, Portland, Ore., states that another wooden shipbuilding plant will be erected in South Portland, Ore.

The Erickson Shipbuilding Company has been organized in Seattle, Wash., C. J. Erickson is president and E. L. Grondahl is secretary.

It is reported that the United States Steamship Company, New York, has selected Hamilton & Chambers, New York, as engineers to design its proposed shipbuilding plant at Groton, Conn.

The Providence Engineering Works, Providence, R. I., has been incorporated, with a capital stock of $500,000, by William E. Hussey, William B. Dukeshire and Edgar H. Mead, all of Brooklyn, N. Y. The company proposes to build a new line of marine engines, and the incorporation papers permit it to carry on a general shipbuilding business.

The Vancouver Dry Docks, Ltd., Vancouver, B. C., have completed plans for the construction of a floating drydock of 18,000 tons capacity. The company announces that it will build a shipbuilding and repair plant as soon as the dock is completed. Charles Meek, of Vancouver, is president.

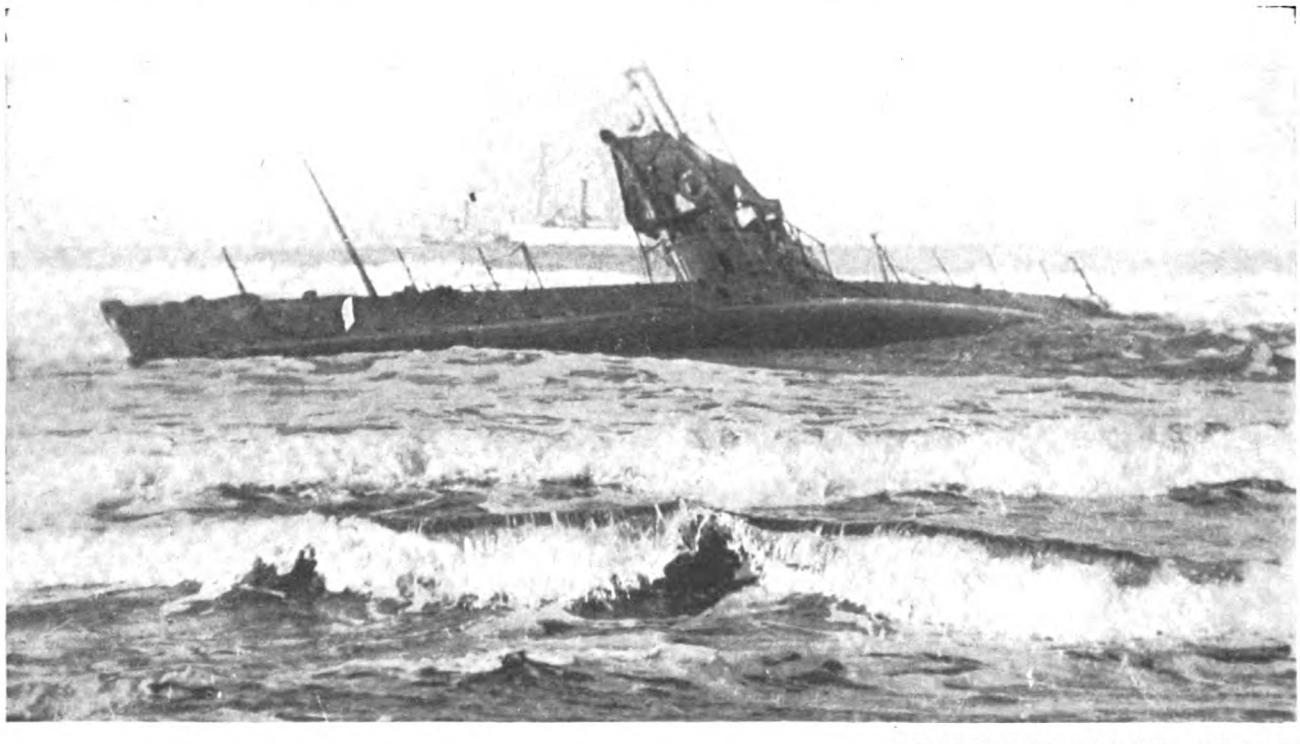
Construction at the Philadelphia Navy Yard of a slip for building one of the four battle cruisers authorized by Congress has been determined upon by Secretary of the Navy Daniels.

The Keyport Dry Dock Company, Keyport, N. J., has taken over the entire plant of the Keyport Marine Railways Company, and is prepared to build and repair scows, barges, lighters and similar craft.

The Albina Engine & Machine Works, Portland, Ore., having received contracts to build four 3,800-ton steel steamers, announces that the plans of its shipbuilding plant have been changed so as to include five ways instead of two as previously announced.

The Lake Torpedo Boat Company, Bridgeport, Conn., will build another large addition to its machine shop and also additions to its docks and warehouses.

The Los Angeles Shipbuilding Company, Los Angeles, Cal., is planning to erect a shipbuilding plant to cost $500,000. E. G.



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United States Submarine *H3*, Stranded on Shoal near Eureka, Cal. The Vessel Went Ashore in a Fog

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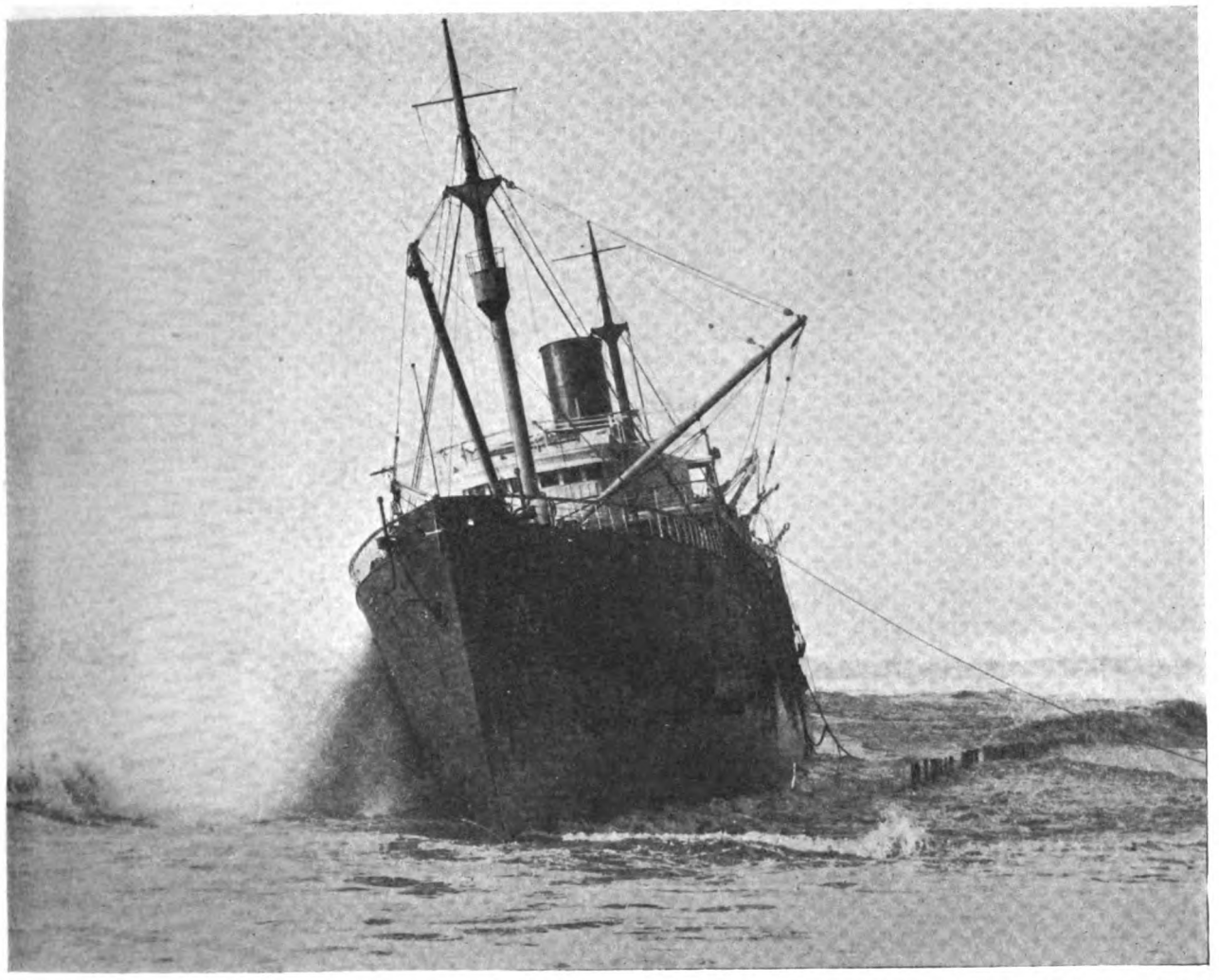

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Storm Drives S. S. *Bear* on the Rocks near Eureka, Cal.

Eckstrom, Los Angeles, is president of the new company.

It is reported that the plant of the Washington Overseas Shipbuilding & Construction Company, Aberdeen, Wash., is near completion. The company is stated to have contracts to build seven auxiliary lumber schooners.

It is announced that the Todd Shipyards Corporation, New York, which controls the Seattle Construction & Dry Dock Company, of Seattle, and other properties, will erect a shipbuilding plant in Tacoma, Wash.

It is reported that Seattle, Wash., shipping men, headed by R. M. Calkin, traffic manager of the Chicago, Milwaukee & St. Paul Railway, are organizing a company to build and operate three steamships to ply between Seattle, Honolulu, Australia and New Zealand.

The Anderson Shipbuilding Company, Seattle, Wash., has been incorporated, with a capital stock of $1,000,000, by J. L. Anderson, E. H. Flick, A. J. Weiffenbach and James Campbell.

The Northwestern Shipbuilding Company has been incorporated, with its main office in the California building, Tacoma, Wash. The capital stock is $100,000. Mr. C. A. Papst, president of the company, writes MARINE ENGINEERING that he is preparing to move the yard to Tacoma, where the company expects to build several large vessels.

The Northwest Marine Construction Company has been organized at Port Townsend, Wash., by A. McFarland, San Francisco, and F. J. Carver and B. M. Pinney, of Seattle.

The Tampa Shipbuilding & Engineering Company, Tampa, Fla., has been incorporated by Ernest Kreher, Peter O. Knight and others, and has acquired the plant of the Tampa Machine & Foundry Company. It is proposed to enlarge the plant and to build steel ships.

It is reported that the Canadian Government is planning an expenditure of $30,000,000 on a shipbuilding plant, terminals and other improvements to the port of Halifax, N. S.

Marine Terminal Improvements

The Pennsylvania Railroad Company, Broad Street Station, Philadelphia, Pa., has asked for bids for improving and enlarging Pier 46, Philadelphia.

The Donner Steel Company, recently incorporated in New York State, with $5,000,000 capital, has taken over the plant of the New York State Steel Company, Buffalo, and will make extensive improvements, including building ore docks along the Buffalo River.

The Norfolk Storage Company, Inc., recently organized at Norfolk, Va., has purchased a site of 19 acres near Norfolk, and will build docks and sheds.

Has Reliability of Motorships Yet Arrived?

The 7,200-ton motorship *Sebastian* arrived in New York on her fourth visit on December 27, having had an exceptionally stormy passage from Rouen, France. One of her two 1,100-indicated horsepower Werkspoor Diesel engines made a non-stop run, and the other was stopped for one hour while a very minor adjustment was being made.

Chief Engineer Cole of the *Sebastian* states that the longest stop of either engine since this vessel was placed in service on June 21, 1916, has been six hours, which was due to a sea water connection breaking and the water getting into the lubricating oil. The engine had to be stopped while the watery oil was drained out and the leak repaired.

Chief Engineer Cole further states that the engines are perfectly reliable, and that he would not hesitate to go to sea with only one engine. Her two main oil engines together averaged a fuel consumption of 5.6 tons of residual oil fuel

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per 24-hour day, while the donkey boilers used 1.9 tons of oil per day.

Launching of S. S. Julia Luckenbach

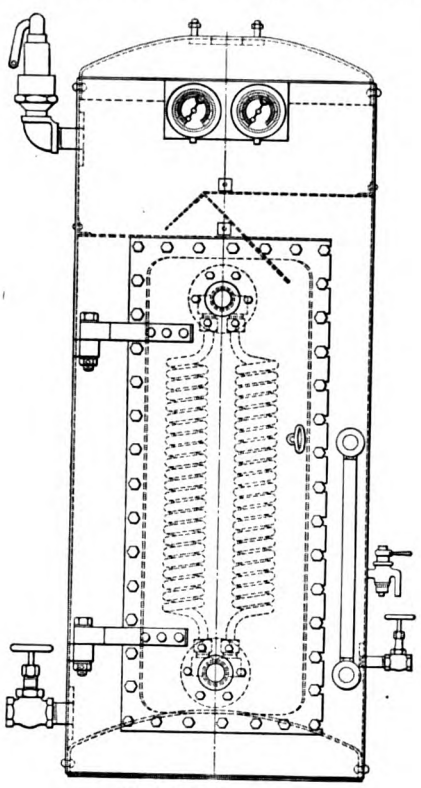
The *Julia Luckenbach,* launched December 23, 1916, sponsor Miss Andrea Tenurck, is the second of a fleet of five large oil-burning freighters now under construction by the Fore River Shipbuilding Corporation for the Luckenbach Line of New York to engage in the general carrying trade. The *Edward Luckenbach,* the first vessel built under the contract, left the Fore River yards three weeks ago, having fulfilled every requirement of her trials.

The *Julia Luckenbach,* like the other vessels of the fleet, was constructed to special designs for the Luckenbach Steamship Company for its coast to coast and oversea trade. Her length is 456 feet over all, and she has a deadweight carrying capacity of 10,000 tons. In the adoption of the modified cruiser stern, the novel arrangement of bridge and deckhouse bulwarks, one large smokestack amidships, she is a handsome vessel of distinctive appearance. Her wide spaced frames are specially designed for the economical carriage and rapid handling of freight.

The vessel is driven by a single Curtis turbine, with high and low-speed reduction gears, designed to deliver 4,000 horsepower at 90 revolutions, the turbine being so arranged that the ahead and reverse turbines are carried on one shaft and contained in one case. Steam is furnished by three boilers of the Scotch marine type, the fuel oil being carried in the double-bottom compartments and in the forward and afterpeak tanks.

Paracoil Evaporator

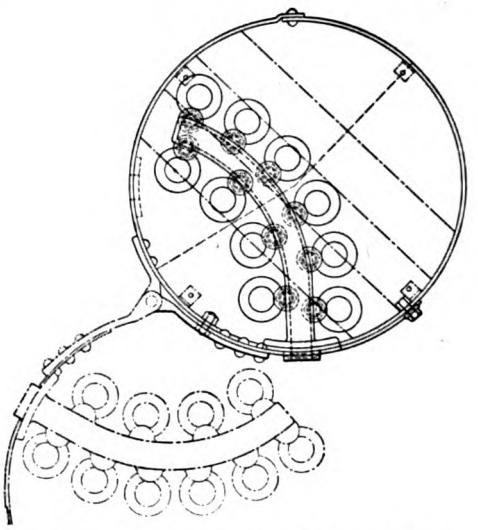
The R & D Paracoil Evaporator, illustrated herewith, which is manufactured by Row & Davis, Engineers, Inc., 90 West street, New York, provides a supply of pure distilled water for boiler feeding, drinking, bottling, manufacturing processes, etc. Steam of any initial pressure from 200 pounds



R & D Evaporator

gage down to atmospheric may be utilized for heating the raw water, so that the evaporator may be operated as a single unit or with multiple effect. Where exhaust steam is available for the heating, the distilled water can be produced without other expense than the upkeep on the evaporator, and an adequate water supply for drinking and other limited use is secured practically for nothing.

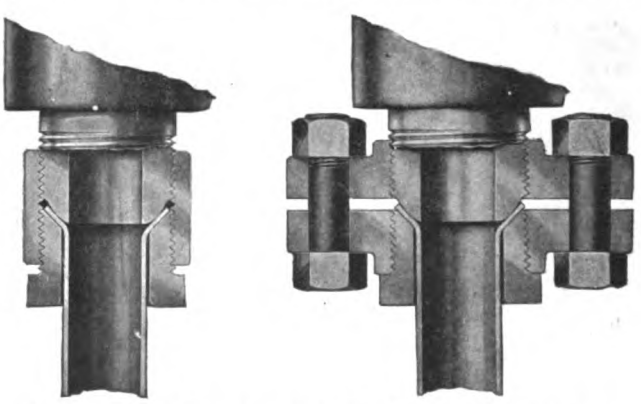
The raw water is fed constantly into the shell of a single-effect, or of the first unit of a multiple effect, plant at a rate corresponding to that of ebullition, the water level carried at any time being always shown by a gage glass. As this water evaporates the impurities are left behind, and when accumulated are removed through a blow-out valve. The distillate is



The New Arrangement of Manifolds Which in Connection with the Hinged Door Makes the R & D Evaporator Easy to Clean

passed to a surface condenser in a single effect, or into the heating coils of the succeeding unit of a multiple-effect, plant.

The raw water is heated to ebullition by steam of higher pressure and temperature circulating and condensing in a group of helical coils arranged for parallel flow between inlet and outlet manifolds and placed respectively in the vapor and water space within the shell. The condensation from the heating coils is trapped out, and if filtered to remove oil, grease or other particles that may float in with the steam, can be reused as boiler feed water, thereby conserving practically all of the contained heat. This heating steam and its condensation do not come into contact with the raw water and vapor, and therefore cannot contaminate the output of the evaporator unit. The vapor in a single-effect plant passes direct to a condenser, from which it is delivered as distilled water ready for use. With the multiple effect principle the vapor from the first unit is passed into the heating coils of the second unit to boil more raw water at lower temperature and under lower pressure in the shell of the second unit and so on throughout the series. The condensation from the heating coils of all units except the first in the multiple-effect plant is trapped individually from each unit into a common drain, which de-



Types of Coil Connections Used in the R & D Evaporator

livers into the same hot well or receiver as does the surface condenser which receives the vapor from the last unit. If the distillate is to be used solely for boiler feeding the returns from the heating coils in the first unit also, if filtered, can be safely passed along into the well or receiver and greater economy thereby effected. As further practical economy the sensible heat in the distillate of the earlier stages can be utilized to heat the steam going into the later stages, which is done by means of interchangers.

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Novel construction features of the R & D evaporator are indicated clearly by the illustrations. The side of the shell is provided with an extra large door, curved to the same radius as the shell metal, hinged, gasketed and held by studs and nuts.

The top and bottom manifolds for steam inlet and condensation drain, respectively, are similar, are of cast iron or bronze, are fastened to the inspection door by flanges, and are of a distinctly new arc type, that in connection with the hinging of the door enables the entire heating section to be swung outside for convenient inspection, cleaning or repair. The form of manifolds permits of an ample area of heating coil surface to be placed toward one side of the shell, which gives a much greater space for the vapor than that occupied by the large body of water from which it is generated. The large free space also affords complete and direct circulation without the vapor currents coming into conflict. A simple but effective form of baffle in the top permits priming.

This construction also has the manifold entirely free from the shell, which minimizes expansion strains and avoids expansion gaskets and leakage.

The coils are of seamless drawn copper, and are of a form that puts practically no strain on the joints. The helical form also permits a very great amount of heating surface to be compacted into small space, and provides for a natural contraction and expansion when the coils are suddenly flooded with cold water for washing off scale. This, to a great extent, eliminates hand washing.

The joints between coils and manifolds are made by slightly flaring the tube end and locking it between a tapered nipple on the manifold and a corresponding brass bushing. The latter is brought up tight by screwing into a brass lock nut that also threads onto the nipple. As an alternative construction for those who prefer a flanged to a locked joint, the lock nut may be replaced by a pair of two-bolt flanges, as shown. Both arrangements permit the blanking out of a coil temporarily by the use of two standard pipe caps or by putting blind washers in the joint.

These evaporators comply in every respect with regulations of the Board of Supervising Inspectors, Steamboat Inspection Service. The shell is tested to 50 pounds and the coils and manifolds to 500 pounds hydrostatic pressure. Sizes are made with capacities up to 75 tons per 24 hours.

Fourth National Foreign Trade Convention

All Americans engaged in or desirous of entering overseas commerce had an unusual opportunity to discuss the development of the American merchant marine at the Fourth National Foreign Trade Convention, held at the William Penn Hotel, Pittsburg, Pa., on January 25 to 27. In addition to the discussion of the conditions affecting the American overseas shipping the programme included a number of the papers by national authorities on such subjects as "World Trade After the War," "America's Position in World Finance," "Co-operation in Foreign Trade," "Commercial Education" and "Problems of Manufacturers and Merchants."

One of the most interesting and instructive papers presented is that on "The Present Position and Prospects of American Shipbuilding," by J. W. Powell, president, Fore River Shipbuilding Corporation, Quincy, Mass., who calls attention to the importance of the opportunities waiting to the hand of the newly-appointed Shipping Board for re-establishing the American merchant marine in foreign commerce.

Battleship Mississippi Launched at Newport News

The 32-ton battleship *Mississippi* was launched at the yards of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., on January 25. The vessel is 600 feet long, 97 feet 4½ inches beam, and 30 feet mean draft. With Curtis turbines of 32,000 horsepower, fitted with reduction gears for cruising, a speed of 21 knots will be developed. The main armament consists of twelve 14-inch guns, arranged in four turrets of three guns each.

Recent Launchings

Percy & Small, Bath, Me., launched on January 13 the wooden auxiliary schooner *Samuel C. Mengel* of 809 gross tons, which is intended for carrying mahogany from the west coast of Africa to Pensacola for Mengel Bros., of Louisville, Ky.

The New York Shipbuilding Corporation, Camden, N. J., launched on January 18 the steam collier *Tidewater* of about 8,500 tons deadweight, for the Darrow-Mann Company, Boston, Mass.

The Newport News Shipbuilding & Dry Docks Company, Newport News, Va., Launched on January 12 the steamship *Felix Taussig*, building for the Crowell & Thurlow Steamship Company, Boston, Mass.

Improvements at Puget Sound Shipyards

The Winslow Marine Railway & Shipbuilding Company, Winslow, Wash., has expended approximately $50,000 in the past sixty days in rearranging car tracks and improving and installing new yard equipment. The company has just completed a new ship shed designed to accommodate vessels 300 feet in length. The shed is equipped with a modern overhead trolley system for handling material, and its erection is part of a plan which calls for four such sheds to be erected at the yard as the demands of new contracts warrant.

The Washington Overseas Shipbuilding & Construction Company, Seattle, Wash., has taken a ten-year lease of the Sumner Iron Works plants at Everett, Wash., which was partially destroyed by fire some time ago. This plant has a water frontage of 1,280 feet, including a wharf, and the equipment also includes a 300-foot floating dry dock.

Personal

HENRY S. GROVE, president of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., handed his resignation to the directors of the company at their January meeting. At the same time Albert Strauss and Francis L. Hine resigned as directors of the company. All three of these men have been closely associated in the management of this extensive shipbuilding property in the past thirteen years.

R. H. BLAKE, formerly in charge of the Australian freight department of Funch, Edye & Company, agents for the Commonwealth & Dominion Line, Ltd., of London, has been appointed manager of the freight business of the Cunard Steamship Company.

REAR ADMIRAL D. W. TAYLOR, chief constructor of the United States Navy, has been promoted to the rank of rear admiral, irrespective of the present duties as head of the Bureau of Construction and Repair.

REAR ADMIRAL ROBERT S. GRIFFIN, engineer-in-chief of the United States Navy, has been promoted to the rank of rear admiral, irrespective of his duties as chief of the Bureau of Steam Engineering.

M. A. HERNANDEZ, 26 Cortlandt street, New York, has assumed charge of the branch office of Johnsen & Kildal, A/S, Christiania, Norway. J. Walter Johnsen is president, Berger Kildal vice-president, and Mr. Hernandez secretary-treasurer and general manager. Mr. Johnsen and Mr. Kildal are at present in Norway.

JOSEPH B. WEAVER, superintendent of hull construction of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has resigned to become vice-president and general manager of the Harlan & Hollingsworth Corporation, Wilmington, Del.

H. PERRY PHELPS has been named plant engineer by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., a position recently created. He will have supervision of the plant machinery, including the installation of a large amount of new machinery for which the company recently made an appropriation.

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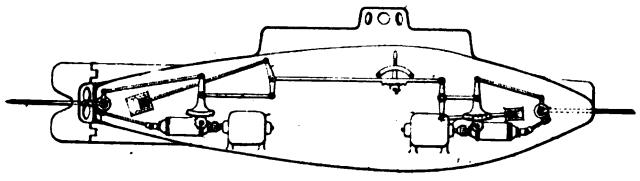
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,187,738. PRESSURE-CONTROLLED GOVERNING APPARATUS. REYNOLD JANNEY, OF NEW YORK, N. Y., ASSIGNOR TO THE WATERBURY TOOL COMPANY, OF NEW BRITAIN, CONN., A CORPORATION OF CONNECTICUT.

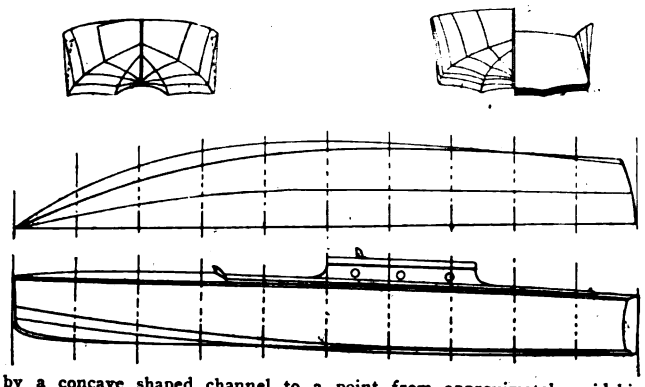
Claim 1.—An apparatus comprising a hydraulic variable speed gear including a controlling device, a governing member operatively connected with the hydraulic variable speed gear, means for operating said



controlling device at will to cause the hydraulic variable speed gear to move the governing member from its neutral position, and pressure controlled means acting upon said controlling device for returning said governing member to its neutral position. Thirteen claims.

1,189,227. BOAT. LEWIS R. BAKER, OF BALTIMORE, MD.

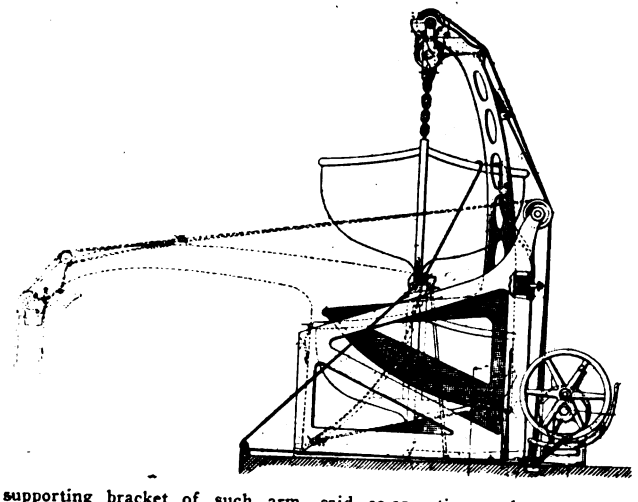
Claim 1.—A hydroplane hull with the planing runners joined rigidly



by a concave shaped channel to a point from approximately midship rearward. Five claims.

1,190,046. AUTOMATIC DAVIT. RICHARD TJADER, OF NEW YORK, N. Y.

Claim 1.—In an automatic davit, the combination of a pair of vertically arranged rigid supporting brackets each having near its base a track member and having sockets formed at the upper and lower ends thereof, a pair of davit arms supported upon said brackets and each including a rocker member co-operating with the track member of the



supporting bracket of such arm, said co-operating rocker and track members having relatively curved and straight coacting surfaces, each rocker member furthermore having at its ends a pair of downwardly projecting toes adapted to co-operate at the ends of the rocking movements with the aforesaid sockets, and a flexible flat metallic strap extending between said engaging surfaces and connected at its opposite ends to the rocker and track members respectively, said flat strap receiving directly the impact and rolling friction between the rocker and the tread member. Eleven claims.

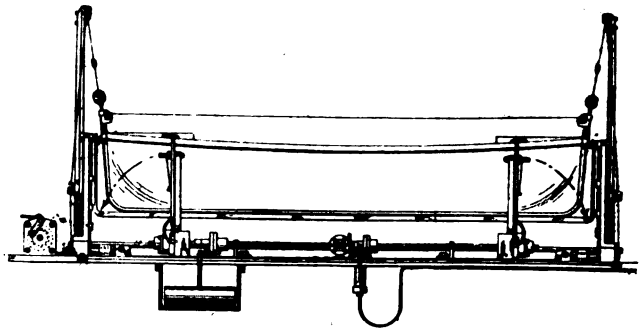
1,189,686. FIRE INDICATING AND EXTINGUISHING SYSTEM. FRANK C. HAASSLER, OF BROOKLYN, N. Y.

Claim 1.—The herein described combined fire indicating and fire extinguishing system for ships, comprising jointly standpipes adapted to extend from the upper deck of said ship down and into the hold and intermediate decks thereof, each of said standpipes provided with an opening and closing valve at its upper portion, each of said standpipes provided at or near its upper end with an announcing or smoke escaping outlet, each of the said standpipes provided at its lower end with perforated branch pipes adapted to convey smoke from the compartment of the ship to the said standpipes or to distribute fire extinguishing mediums from the said standpipes into the compartments of said ship, fire extinguishing supply pipes in pairs adapted to lie in close proximity to said standpipes, means for connecting said supply pipes to the said standpipes, each consisting of a permanent Y coupling, whereby the said standpipes can be supplied with one or both mediums for extinguishing fires at the same time, said Y couplings provided with opening and closing valves and cocks, and means for supplying the said supply pipes with the extinguishing mediums. Four claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

101,520/16. "IMPROVEMENTS IN OR RELATING TO DAVITS." G. J. PHILLIPS, COMMERCIAL BROKER, AND L. A. KELLER, ELECTRICAL ENGINEER, BOTH OF 17A PITT STREET, SYDNEY, AUSTRALIA.

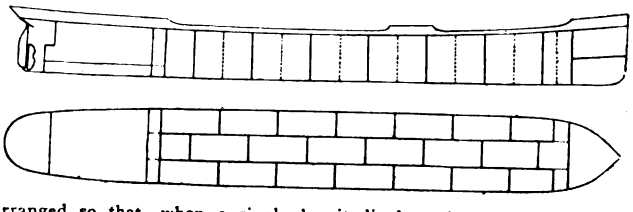
This invention has reference to davit arrangements and more especially those intended for use with means for holding and releasing boats, rafts, and the like, on board ships. In the specification of former letters patent No. 25,477, of 1912, and the specifications of applications for letters patent No. 11,032, of 1915, and No. 7131, of 1916, holding and releasing means are described in connection with which the present improvements are especially applicable. According to the present invention the davits of the kind that are pivoted near their lower ends and tend to swing outward automatically when they take the weight of the boat are formed, below their pivots with toothed quadrants geared



through toothed wheels with a common longitudinal shaft so that the davits swing in and out together. If the vessel has a considerable list it may happen that the davits will be so inclined inboard that they will not swing outwards when the weight of the boat is taken, and our invention comprises improved means for overcoming this difficulty, such means enabling the davits to be positively swung outboard until they pass beyond the vertical by means of hand lever with pawl provided in connection with a gear wheel on the longitudinal shaft whereby the shaft can be rotated sufficiently for the purpose, a detent preventing backward rotation of the shaft between the operative strokes of the lever; the detent may be so arranged as to be disengaged by the lever towards the end of its idle stroke so that the detent will not then prevent the davits being swung inboard again. If desired, the levers may be adapted to actuate the shaft so as to swing the davits inboard, for instance, the pawl may be reversible so as to work in either direction.

16,016/15. "IMPROVEMENTS RELATING TO SHIPS FOR CARRYING LIQUID CARGOES IN BULK." H. LAING, SHIPBUILDER, OF DEPTFORD YARD, AND E. W. ASHBY, NAVAL ARCHITECT, OF 4, DUNBAR STREET, BOTH IN SUNDERLAND, IN THE COUNTY OF DURHAM.

This invention relates to ships for carrying liquid cargoes in bulk, such as oil or molasses, and has for its object to provide an improved construction thereof, whereby increased longitudinal strength and other advantages are obtained. In a liquid cargo carrying vessel of the type known as a "tanker" one or more of the transverse bulkheads is or are



arranged so that, when a single longitudinal straight-line bulkhead if provided and the cargo space thus divided into two longitudinal compartments, the portions of the transverse bulkheads crossing the compartments on each side of said longitudinal bulkheads are not in line the one with the other, but are stepped a convenient distance away, and where two longitudinal straight-line bulkheads are provided and the cargo space divided into three longitudinal compartments, one or more of the bulkheads crossing the center longitudinal compartment are not in line with the bulkheads crossing the side longitudinal compartments, but are stepped a convenient distance away.

17,817/15. "IMPROVED MEANS FOR FASTENING SHIPS' ROPES TO MOORING BUOYS, MOORING RINGS, AND THE LIKE." W. J. JOHNSON, OF 43 CORBRIDGE STREET, SOUTH SHIELDS, IN THE COUNTY OF DURHAM, RIGGER AND STEVEDORE.

The end of the wire rope is provided with the usual large loop or eye formed by bending the rope back on itself and joining the end to the rope by splicing or other method. A comparatively long metallic sleeve or ferrule is threaded on the rope and over the splicing, the hole through the sleeve being tapered and shaped to fit the splicing. A lateral lug or elbow shaped projection is formed on one side of the sleeve comprising means whereby a separate shackle of suitable strength or the loop itself can be easily attached to said lug or projection.

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